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VENDOR REQUIREMENTS

FUEL CELL ASSEMBLY,

ELECTRICAL POWER SUBSYSTEM

FOR

LUNAR EXCURSION MODULE [U]

LVR-390-2

4-29-63

SUBMITTED IN ACCORDANCE WITH
PARA. 4.2 OF EXHIBIT E
OF NASA CONTRACT NAS 9-1100

6.4

Approved By R. Mullaney
R. Mullaney
Program Manager

Grumman LEM

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INTRODUCTION

The contractor shall supply the necessary skills, services, materials and equipment as specified herein in support of the Lunar Excursion Module development of the Apollo spacecraft.

The objective of Project Apollo is a landing of men on the moon, limited observation and exploration of the moon by the crew in the landing area, and return to earth. The Apollo Development Plan envisions the qualification of the spacecraft and its modules in a series proceeding from sub-orbital through earth orbital and lunar orbital to lunar landing mission.

The lunar orbit rendezvous technique will be used to perform the lunar landing mission. Employing this technique, the spacecraft consisting of the Command Module, Service Module, and Lunar Excursion Module is injected into a translunar trajectory. In lunar orbit the Lunar Excursion Module with two crew members aboard separates from the Command and Service Module and descends to a lunar landing. The third crew member remains in the Command Module in lunar orbit. After the crew performs their mission objective tasks, the Lunar Excursion Module returns to lunar orbit with the records and specimens obtained. The Lunar Excursion Module performs a rendezvous and docking maneuver with the Command Module. The crew and payload transfer to the Command Module and the Command Module, without the Lunar Excursion Module is injected into a transearth trajectory by the Service Propulsion System.

The information presented in the following pages constitutes the vendor requirements for the development of the equipment specified herein in support of the Grumman development of the Lunar Excursion Module.

SCOPE

This document establishes the minimum requirements for the Fuel Cell Assembly (FCA), Development Program for use in the Lunar Excursion Module, Project Apollo Spacecraft. This Vendor Requirement (VR) is subdivided into the following major sections:

SECTION A - Materials and Services: A summary of the cost breakdown required is presented in this section. Exact format of cost elements required to support this section is to be presented as requested in Section G, "Instructions for Preparation of Proposal".

SECTION B - Deliveries and Destination: A summary of all deliverable hardware and documentation is presented in this section.

SECTION C - Task Description: A complete task description covering all of the technical requirements necessary to define the cost breakdown summarized in Section A is presented herein. The performance Specification supplements as indicated the Detail Equipment Requirements.

SECTION D - Special Provisions: This section presents additional requirements and procedures supplementing the specified technical description presented in Section C.

SECTION E - Documentation: A summary of all documentation requirements is presented in this section. A schedule indicating the items of documentation, delivery dates, quantities, documentation type, form and number of copies is listed in Table I.

SECTION F - Terms and Conditions: This section presents the legal clauses required by Grumman Procurement Policy as modified by the prime contract with NASA.

SECTION G - Instructions for Preparation of Proposal: Presented herein are specific instructions for preparation of your proposal. Deviations from these requirements could be considered as a nonresponsive proposal.

APPLICABLE DOCUMENTS

The documents listed below shall form a part of this Vendor Requirement to the extent specified herein.

Document No.	Title
LSP-390-2	Assembly, Fuel Cell Electrical Power Lunar Excursion Module, Specification for, dated 29 April 1963
QCP 2.11	Grumman Quality Control Requirements Subsystems, dated 5 February 1963 (enclosed in Section D)
Handbook	NASA PERT and Companion Costs Handbook, dated 30 October 1962
NPC 200-2	Quality Program Provisions for Space System Contractors, dated April 1962

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SECTION A - MATERIALS AND SERVICES

Presented herein is a summary of the cost breakdown required. Exact format of cost elements required to support this summary are to be presented as requested in Section F, "Instructions for Preparation of Proposal".

SECTION A

MATERIALS AND SERVICES

Item		Sub-Item Total	Item Total
1	REACTANT CONTROL COMPONENTS DEVELOPMENT		$_____
	1.1 Engineering (Design)	$_____	
	1.2 Tooling	$_____	
	1.3 Fabrication	$_____	
	1.4 Development Testing	$_____	
2	REACTOR SUBASSEMBLY DEVELOPMENT		$_____
	2.1 Engineering	$_____	
	2.2 Tooling	$_____	
	2.3 Fabrication	$_____	
	2.4 Development Testing	$_____	
3	ELECTRICAL SUPERVISORY SUBASSEMBLY DEVELOPMENT		$_____
	3.1 Engineering	$_____	
	3.2 Tooling	$_____	
	3.3 Fabrication	$_____	
	3.4 Development Testing	$_____	
4	FUEL CELL ASSEMBLY DEVELOPMENT		$_____
	4.1 Engineering (Integration of Subassemblies)	$_____	
	4.2 Tooling	$_____	
	4.3 Fabrication	$_____	
	4.4 Development Testing	$_____	
	4.5 Qualification Testing	$_____	
	4.6 Acceptance Testing	$_____	
5	SPECIAL TEST EQUIPMENT		$_____
	5.1 Design	$_____	
	5.2 Fabrication	$_____	
	5.3 Check-out	$_____	

MATERIALS AND SERVICES (Continued)

Item		Sub-Item Total	Item Total
6	MOCKUPS		$_____
	6.1 Soft (wood) (1)	$_____	
	6.2 Hard (metal) (3)	$_____	
	6.3 Thermal (3)	$_____	
7	FUEL CELL ASSEMBLY		$_____
	7.1 Experimental Model (1)	$_____	
	7.2 Developmental Model (3)	$_____	
	7.3 Prototype Model (12)	$_____	
	7.4 Production Model (15) (Ground Test)	$_____	
	7.5 Production Model (30) (Flight Test)	$_____	
8	CONTAINERS		$_____
	8.1 Design	$_____	
	8.2 Fabrication (36)	$_____	
9	SUPPORT EQUIPMENT		$_____
10	DOCUMENTATION		$_____
11	FIELD SUPPORT - GRUMMAN		$_____
12	PROGRAM MANAGEMENT		$_____
13	TRAINING		$_____

Total Program Cost $_____

The following data is for budgetary and planning purposes:

14	FOLLOW-ON DELIVERIES	
	14.1 Fabricate (9) Fuel Cell Assemblies	$_____
	14.2 Fabricate (45) Fuel Cell Assemblies	$_____
	14.3 Fabricate (90) Fuel Cell Assemblies	$_____
	14.4 Fabricate (180) Fuel Cell Assemblies	$_____

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SECTION B - DELIVERIES AND DESTINATION

A summary of all deliverable items and dates is presented in this section.

SECTION B

DELIVERIES AND DESTINATIONS

NOTE: Sixty days prior to each delivery date the vendor shall request detail shipping instructions from Grumman.

Item		Cumulative	Rate	Delivery Date	Destination
1	REACTANT CONTROL COMPONENTS DEVELOPMENT			Not Applicable	
2	REACTOR SUBASSEMBLY DEVELOPMENT			Not Applicable	
3	ELECTRICAL SUPERVISORY SUBASSEMBLY DEVELOPMENT			Not Applicable	
4	FUEL CELL ASSEMBLY DEVELOPMENT			Not Applicable	
5	SPECIAL TEST EQUIPMENT			Not Applicable	
6	MOCK-UPS				
	6.1 Soft (wood)	1	1	11-1-63	Grumman
	6.2 Hard (metal)	4	3	12-1-63	Grumman
	6.3 Thermal Model	7	3	2-1-63	Grumman
7	FUEL CELL ASSEMBLY				
	7.1 Experimental Model	1	1	11-1-63	Grumman
	7.2 Developmental Model	4	3	3-1-64	Grumman
	7.3 Prototype Model	7	3	7-1-64	Grumman
		10	3	8-1-64	MSC
		13	3	9-1-64	Grumman
		16	3	10-1-64	Grumman
	7.4 Production Model (Ground Test)	19	3	12-1-64	Grumman
		22	3	2-1-65	Grumman
		25	3	3-1-65	Grumman
		28	3	4-1-65	Grumman
		31	3	5-1-65	Grumman

DELIVERIES AND DESTINATIONS (Continued)

Item		Cumulative	Rate	Delivery Date	Destination
7	(Continued)				
	7.5 Production Model (Flight Test)	34	3	6-1-65	Grumman
		37	3	7-15-65	Grumman
		40	3	9-15-65	Grumman
		43	3	11-1-65	Grumman
		46	3	2-1-66	Grumman
		49	3	4-1-66	Grumman
		52	3	6-1-66	Grumman
		55	3	9-1-66	Grumman
		58	3	12-1-66	Grumman
		61	3	3-1-67	Grumman
8	CONTAINERS				
	NOTE: Each Fuel Cell Assembly shall be delivered in a shipping container in accordance with LSP-420-				
	8.2 Fuel Cell; Reusable	36			
9	SUPPORT EQUIPMENT			Not Applicable	
10	DOCUMENTATION				
	NOTE: A summary of all documentation requirements including specific delivery dates is presented in Section E, Table I.				
11	FIELD SUPPORT - GRUMMAN			Not Applicable	
12	PROGRAM MANAGEMENT			Not Applicable	
13	TRAINING			Not Applicable	
14	FOLLOW-ON DELIVERIES			Not Applicable	

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SECTION C - TASK DESCRIPTION

A complete task description covering all of the technical requirements necessary to define the cost breakdown summarized in Section A is presented herein. The Design Control Specification supplements the Detail Equipment Requirements as indicated.

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TASK DESCRIPTION

1. REACTANT CONTROL COMPONENTS DEVELOPMENT

1.1 Engineering. - Provide the engineering design and analysis effort necessary for the design of the Reactant Control Components in accordance with the requirement of Grumman Specification LSP-390-2.

1.2 Tooling. - Provide the necessary design, fabrication, and checkout effort for the tooling (e.g. dies, jigs, fixtures, etc.) required to fabricate Reactant Control Components. The vendor shall state the production capability in terms of; production rate of components/month.

1.3 Fabrication. - Fabricate all component hardware required for the Reactant Control Component Development Program in accordance with the requirements of Grumman Specification LSP-390-2. Fabrication is defined as all the raw materials, engineering, labor and burden associated with manufacturing, assembly and inspection necessary to produce a specific item.

1.4 Development Testing. - Provide the effort necessary to test the Reactant Control Components in accordance with LSP-390-2. Test data reduction and test analysis shall be included. The test program shall define the relationship of components required, number of tests (runs) and duration.

2. REACTOR SUBASSEMBLY DEVELOPMENT

2.1 Engineering. - Provide the engineering design and analysis effort necessary for the design of the Reactor Subassembly Components in accordance with the requirements of Grumman Specification LSP-390-2.

2.2 Tooling. - Provide the necessary design, fabrication and checkout effort for the tooling (e.g. dies, jigs, fixtures, etc.) required to fabricate Reactor Subassembly Components. The vendor shall state the production capability in terms of; production rate of components/month.

2.3 Fabrication. - Fabricate all component hardware required for the Reactor Subassembly Component Development Program in accordance with the requirements of Grumman Specification LSP-390-2. Fabrication is defined in 1.3.

2.4 Development Testing. - Provide the effort necessary to test the Reactor Subassembly Components in accordance with LSP-390-2. Test data reduction and test analysis shall be included. The test program shall define the relationship of components required, number of tests (runs) and duration.

TASK DESCRIPTION (Continued)

3. ELECTRICAL SUPERVISORY SUB-ASSEMBLY (ESS) DEVELOPMENT

3.1 Engineering. - Provide the engineering design and analysis effort necessary for the design of the ESS components in accordance with the requirements of Grumman Specification LSP-390-2.

3.2 Tooling. - Provide the necessary design, fabrication and checkout effort for the tooling (e.g. dies, jigs, fixtures, etc.) required to fabricate ESS components. The vendor shall state the production capability in terms of; production rate of components/month.

3.3 Fabrication. - Fabricate all component hardware required for the ESS Component Development Program in accordance with the requirements of Grumman Specification LSP-390-2. Fabrication is defined in 1.3.

3.4 Development Testing. - Provide the effort necessary to test the ESS components in accordance with LSP-390-2. Test data reduction and test analysis shall be included. The test program shall define the relationship of components required, number of tests (runs) and duration.

4. FUEL CELL ASSEMBLY DEVELOPMENT

4.1 Engineering. - Provide the engineering design effort necessary to integrate the sub-assemblies and fabricate a complete Fuel Cell Assembly in accordance with Grumman Specification LSP-390-2.

4.2 Tooling. - Provide the design, fabrication and checkout effort for tooling (such as dies, jigs, fixtures, etc.) required to fabricate the Fuel Cell Assemblies. The vendor shall state the production capability in terms of; production rate of components/month.

4.3 Fabrication. - Fabricate all items required for the integration of the sub-assemblies to provide the complete Fuel Cell Assembly in accordance with the requirements of Grumman Specification LSP-390-2. Fabrication is defined in 1.3.

4.4 Tests. -

4.4.1 General. - The vendor shall provide all the effort necessary for test set-ups and instrumentation including maintenance and calibration. This item shall not include the fabrication or purchase of additional test equipment that has been provided for in Item 5.

TASK DESCRIPTION (Continued)

4.4.2 Development Tests. - The vendor shall provide all the effort necessary for conducting development tests on the Fuel Cell Assembly. This shall include preparation of a Test Plan subject to Grumman approval and submission of a Development Test Report completely describing the results of any tests conducted as well as full information on test set-ups and instrumentation. The test program shall include all tests necessary to establish design feasibility and verify Design Capability in accordance with the requirements of LSP-390-2. Design Verification Tests shall include tests to reliability assurance levels.

4.4.3 Qualification Tests. - The vendor shall provide all the effort necessary for conducting Qualification Tests on the Fuel Cell Assembly. This shall include preparation of a Test Plan subject to Grumman approval and submission of a Qualification Test Report completely describing all tests conducted as well as full information on test set-ups and instrumentation. The test program shall include all tests necessary to meet the requirements for Qualification in accordance with LEM Specification LSP-390-2.

4.4.4 Acceptance Tests. - The vendor shall provide all necessary effort to conduct Acceptance Tests in accordance with the approved Acceptance Test Plan. This shall include preparation of the Acceptance Test Plan subject to Grumman approval, test set-up, instrumentation, and recording of test results. Test data reduction and recording shall be in accordance with the Quality Assurance Provisions of LEM Specification LSP-390-2.

5. SPECIAL TEST EQUIPMENT

The vendor shall provide test support hardware required for handling, installation, control and instrumentation (including sensors, recorders, displays, etc.) peculiar to this program, necessary to meet the test requirements specified in LSP-390-2.

6. MOCKUPS

6.1 Soft (Wood). - The vendor shall design and fabricate one (1) soft mock-up. The soft mock-up shall be constructed basically of wood simulating the form factor and all interfaces.

TASK DESCRIPTION (Continued)

6.2 Hard (Metal). - The vendor shall design and fabricate one (1) hard mock-up. The hard mock-up shall be constructed basically of metal simulating the form factor and all interfaces of the production model.

6.3 Thermal. - The vendor shall design and fabricate three (3) thermal mock-ups. The thermal mock-up shall be constructed to demonstrate the thermal characteristics of the fuel cell assembly when operating under varied load conditions. Tests shall be conducted to verify the thermal characteristics.

7. FUEL CELL ASSEMBLY

7.1 Fabrication. - The vendor shall fabricate and deliver one (1) experimental model fuel cell assembly in accordance with Grumman Specification LSP-390-2 and Section B of LVR-390-2. The fuel cell assembly shall be capable of delivering full rated electrical output prior to delivery. See 1.3.

7.2 Fabrication. - The vendor shall fabricate and deliver three (3) developmental model fuel cell assemblies in accordance with the Grumman Specification LSP-390-2 and Section B of LVR-390-2. The fuel cell assemblies shall successfully complete the Acceptance Test prior to delivery. See 1.3.

7.3 Fabrication. - The vendor shall fabricate and deliver twelve (12) prototype model fuel cell assemblies in accordance with the Grumman Specification LSP-390-2 and Section B of LVR-390-2. The fuel cell assemblies shall successfully complete the Acceptance Test prior to delivery. See 1.3.

7.4 Fabrication. - The vendor shall fabricate and deliver fifteen (15) production model fuel cell assemblies for Ground Test in accordance with the Grumman Specification LSP-390-2 and Section B of LVR-390-2. The fuel cell assemblies shall successfully complete the Acceptance Test prior to delivery. See 1.3.

TASK DESCRIPTION (Continued)

7.5 Fabrication. - The vendor shall fabricate and deliver thirty (30) production model fuel cell assemblies in accordance with the Grumman Specification LSP-390-2 and Section B of LVR-390-2. The fuel cell assemblies shall successfully complete the Acceptance Test prior to delivery. See 1.3.

8. CONTAINERS

8.1 Design. - The vendor shall provide the effort necessary for the design of the Fuel Cell Assembly shipping container in accordance with the requirements of Grumman Specification LSP-420-

8.2 Fuel Cell Assembly Container (reuseable). - Fabricate and deliver thirty six (36) fuel cell containers in accordance with the Grumman Specification LSP-420- . See 1.3

9. SUPPORT EQUIPMENT

Provide the necessary effort to define the recommended requirements for the ground support equipment. The study of the ground support equipment should consider two (2) aspects, namely:

(a) Ground checkout systems required in support of the Grumman test at Grumman, Bethpage.

(b) Ground checkout systems required for vehicle launch operations at Atlantic Missile Range.

10. DOCUMENTATION

Provide the documentation required for the program as specified in Section E. A summary schedule indicating the items of documentation type, form and numbers of copies is listed in Table I of Section E. The exact dates for submittal of all documentation is as specified in Section E.

11. FIELD SUPPORT

Provide the necessary field support effort to Grumman at the following locations specified herein. This support shall include advice and assistance in the integration of the FCA into the electrical power subsystem, FCA maintenance, checkout and testing. A major responsibility of this effort will be to provide immediate response to engineering problems that occur to insure the necessary corrective action.

TASK DESCRIPTION (Continued)

11. (Continued)

NOTE: The data requested for Field Support is for planning purposes and shall not be considered part of the basic program.

12. PROGRAM MANAGEMENT

This effort should include the program staff responsible for directing the overall project effort which cannot be identified to any specific category herein. Personnel assigned to provide technical liaison between Grumman and the vendor and the effort associated with PERT information shall be provided as part of this task.

13. TRAINING

The vendor shall provide the effort necessary for an intensive on the job training program at the vendor facility as part of this task. This training shall be oriented towards familiarization of Grumman technician, inspection, and engineering type personnel in the operation, maintenance, installation and checkout of the Fuel Cell Assembly. This training effort will be provided for approximately twenty (20) Grumman personnel.

14. FOLLOW-ON DELIVERIES

Provide an estimate of fuel cell assembly deliveries for the quantities as specified in Section A. The vendor shall specify any limitation and/or assumptions made in providing these costs. Assume a rate of nine (9) fuel cell assemblies per month for all deliveries, assuming initiation of these deliveries following those required as part of Item 8.

NOTE: The data requested for Follow-On Deliveries is for planning purposes and shall not be considered part of the basic program.

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SECTION D - SPECIAL PROVISIONS

This section presents additional requirements and procedures supplementing the specific technical description presented in Section C.

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SECTION D

SPECIAL PROVISIONS

1. SUBCONTRACTOR CHANGE PROPOSAL PROCEDURE

1.1 Introduction. -

1.1.1 (As used in this procedure, the term "Purchase Order" shall include subcontracts, and the term "Vendor" shall include the subcontractors).

1.1.2 This procedure is designed to avert costly misunderstandings which may arise through conflicting or unauthorized instructions. It requires vendors to furnish sufficient information for evaluation by Grumman before changes are authorized by Purchase Order Amendments.

1.1.3 The Purchase Order is the only contractual agreement between Grumman and its vendors. It defines completely the extent of the vendor's contributions and obligations. If the scope of work as specified in the Purchase Order is to be revised, such revisions must be technically approved by Grumman and reflected in the Purchase Order by an Amendment that defines completely such changes. The vendor shall not implement the change until such time subsequent to the issuance of the amendment.

1.1.4 This procedure is not intended to prevent Engineering or technical personnel from rendering assistance or giving technical advice or exchanging information in liaison efforts concerning work to be performed. This may be accomplished by means of appropriate correspondence. Such communications, however, will not obligate Grumman contractually. Grumman will not be liable for additional costs resulting from unauthorized work.

1.2 Procedure. -

1.2.1 The vendor shall submit a change proposal on his own initiative or at the request of Grumman.

1.2.2 The vendor must submit proposals for changes on Form No. GD-1579, "Subcontractor Change Proposal", supported as applicable by "Subcontractor's Cost Proposal Analysis." (Figure D-1)

1.2.3 Grumman, after evaluation of such proposals, shall:

(a) Authorize performance of work by the vendor in an appropriate written Purchase Order or Purchase Order

SPECIAL PROVISIONS (Continued)

1.2.3 (Continued)

(a) Amendment -- or prior written authorization to proceed with such performance -- signed by the Manager of Procurement, or

(b) Notify the vendor in writing that the proposed change was not approved.

1.2.4 Under no circumstances will any vendor be reimbursed for any work performed involving such changes if he proceeds without authorization as outlined above.

1.3 INSTRUCTIONS TO VENDORS for the preparation and submission of a change proposal on Forms GD-1579 and GD-1580:

(a) Items in the SCP From are self-explanatory except:

ITEM 3 Insert the Buyer's name opposite the P.O number.

ITEM 4 For identification, assign Change Proposal numbers in straight numberical order on each individual Purchase Order.

ITEM 19 Submit a firm cost proposal, whether increase or decrease, for the change as proposed. This must be accompanied by appropriate cost breakdowns showing direct and indirect costs of Engineering, Tooling, Manufacturing and Quality Control segregated as to recurring and non-recurring charges. If obsolescence costs will result from the proposed change, account for them separately. (If the proposal is approved obsolescence costs must be reported separately in accordance with ASPR Termination Regulations). If there is no change in cost, enter "none."

ITEM 20 If retrofit is recommended, submit a firm cost proposal, whether increase decrease, for the kits or parts as proposed. This must be accompanied by appropriate cost breakdown (as above), and a Bill of Materials for the retroactive change kit or parts.

SPECIAL PROVISIONS (Continued)

1.3 (Continued)

(b) If additional space is required for any item, attach supplementary page(s) (Form GD-1580). When necessary, supplement the proposal with sketches, drawings and other documents, in triplicate.

(c) The security classification of the information contained in the proposal must be stamped in the blocks provided and current security regulations must be observed in handling and transmittal.

(d) Forward the original ("Action" Copy) and four information copies to:

Purchasing Agent, LEM Business Office
Grumman Aircraft Engineering Corporation
Bethpage, Long Island, New York

(e) Direct all inquiries regarding change proposals to the attention of the cognizant Administrator.

2. QUALITY CONTROL PROGRAM

2.1 The vendor shall, as an integral part of the design, development manufacturing and test program, plan and implement a quality control program in accordance with the Quality Control Requirements-Vendors (LEM Subsystems) Grumman Quality Control Procedure No. 2.11, dated February 5, 1963 (enclosed herein).

3. RELIABILITY PROGRAM

3.1 General. - These requirements constitute the minimum program necessary to assure the attainment of the reliability and operating life specified in the equipment detail specifications and the minimum reliability data to be furnished to Grumman.

3.1.1 As an integral part of the design, development, manufacturing and test program the vendor shall plan and implement a reliability program to assure that a high level of reliability is achieved.

3.1.2 Attainment of the maximum mission reliability and crew safety shall be the most important single consideration in the design, construction, handling and operation of the Lunar Excursion Module equipment.

SPECIAL PROVISIONS (Continued)

3.1.3 Personnel performing reliability program functions shall have sufficient, well-defined responsibility and the organizational freedom to recognize and correct problems and to initiate, recommend, and/or provide solutions.

3.2 The technical term "reliability" as used in this specification is a measure of the excellence of the design and manufacturing, and of the suitability of the end-product for its intended use. The true reliability of a product will only be disclosed in actual use after the product is in the hands of the customer. The term "reliability" shall include maintainability, suitability, and other similar measures of the degree to which the product satisfies its intended use.

3.3 The quantity of equipments to be produced for a program of this nature does not permit gradual reliability improvement throughout a relatively long production and operational life. Reliability must be designed initially into all equipments and maintained and controlled throughout all phases. Failures must be avoided in order to achieve crew safety and mission success. Failures cause serious schedule delays which in turn reduce the probability of success as launch windows are limited to relatively short periods when the relationship between the earth and the spacecraft destination is optimum.

3.4 Vendors shall exercise effective reliability control over all in-plant and supplier products by implementing the following program:

(a) Vendors shall apportion their reliability requirements to all components in their equipment.

(b) Vendors shall determine all pertinent operating characteristics and strength margins of all materials, components and parts used in their equipments, under the anticipated operational stresses and environments. The terms "strength" and "stress" shall be interpreted in the broadest sense to include, respectively, all factors either resisting or tending to produce equipment failure or malfunction. "Strength" is always measured in a test-to-failure.

(c) Vendors shall provide assurance on a current basis that:

SPECIAL PROVISIONS (Continued)

3.4 (Continued)

(c) (1) Adequate safety margins or deratings exist in all parts, components and materials such that each part and component will meet or exceed its apportioned reliability requirement under anticipated operational loads and environments.

(2) The design is an optimum for its intended use.

(3) The reliability of the final product meets or exceeds the specified requirement.

(d) Vendors shall plan and conduct all test programs so that whenever possible the test results can be used:

(1) To validate assumptions made in the analyses and predictions of (c) above, in particular to demonstrate the basic strength of components at specified confidence levels.

(2) To demonstrate the achievement of part, component, or equipment reliability requirements and margins of safety.

(3) To verify the results of failure effect analyses.

(e) Vendors shall establish adequate procedures to assure that the inherent reliability and safety margins attained in the design will be maintained during fabrication and subsequent operations.

(f) Vendors shall establish economical reporting procedures which will enable Grumman to monitor conveniently all phases of their activities connected with the program specified in the contract.

3.5 Reliability Procedures and Documentation. - The procedures, analyses, and associated documentation which the vendor shall utilize to implement his reliability program are specified in Section E "Documentation."

SPECIAL PROVISIONS (Continued)

4. GRUMMAN RESIDENT REPRESENTATION

Grumman will assign representative(s) to the vendor's facility to provide a means of communication and progress surveillance. The representative(s) shall continually monitor the vendor's design, development and qualification effort including the eventual deliveries. The vendor shall provide the resident representative(s) access to informal documentation generated under this purchase order as well as copies with enclosures of all outgoing correspondence and formal reports to Grumman.

4.1 It is required that the vendor supply sufficient office space and secretarial help. This item to be discussed at the time of negotiation.

4.2 The Grumman technical representative to the vendor facility will be provided the privilege of reviewing and signing all drawings prior to release. This provision is predicated on the desire of having the Grumman representative(s) "note" actual effort being performed. This requirement in no way negates any other vendor requirements specified herein.

5. MONITORING AND REVIEW PLAN

5.1 Quarterly Program Review Meetings. - This is a one-day review devoted to program progress and will include a review of manpower, facilities, organizational problems, cost and schedules. This will be held at the vendor's facilities.

5.2 Monthly Meetings. - The monthly meetings between the vendor and Grumman constitute the primary personal contact for review and monitoring of the detail development program at the working level. On specific occasions it might be desirable to have second tier subcontract personnel in attendance at these meetings. Minutes will be published by Grumman and the appropriate content thereof, as approved by the LEM Purchasing Manager, will constitute technical direction to the vendor. Meeting agendas will be jointly determined between the Grumman and vendor project personnel at least one week prior to each meeting. These meetings will normally convene at Grumman on a scheduled monthly basis. They may, on occasion, be convened at the vendor's plant.

SPECIAL PROVISIONS (Continued)

5.3 Other Meetings. - From time to time as the program develops, there will be a need for less formal meetings primarily for the exchange of technical information. It is desired that there be sufficient mutual confidence between Grumman and the vendor that these meetings can take place with minimum disruption of useful work. The object is the exchange of technical information.

5.4 Technical Direction. - Technical direction can originate only from the designated subsystem engineer. Technical direction resulting in cost changes can not be acted upon until authorized by purchase order amendments. (As outlined herein under "Subcontractor Change Proposal Procedure").

6. WEIGHT AND BALANCE CONTROL

6.1 It shall be the responsibility of the vendor to establish and maintain a weight and balance program to fulfill the requirements of weight control.

6.2 The vendor shall have an active and workable weight control program to assure that the element, component or section weight(s) will not exceed the maximum weight and shall otherwise be compatible with the requirements specified in Grumman Specification LSP-390-2.

6.3 Grumman in the course of normal liaison, reserves the right to review the design and recommend weight savings.

7. RIGHTS OF ACCESS TO VENDOR FACILITIES

7.1 In addition to accommodating resident representation, the vendor shall upon request, provide access by other Grumman personnel to his facility to review the area, machines, procedures, test equipment and personnel involved in the design, manufacture and processing of equipment to be purchased. Such facility survey may be requested by Grumman at any time prior to or during the performance of this purchase order.

8. GRUMMAN SUPPLIED TOOLING

8.1 It is the intent of Grumman to supply any tooling necessary for mechanical interface coordination.

8.2 Each deliverable item will be considered acceptable for physical dimensions of mechanical interfaces by Grumman only when it has been certified by Grumman Quality Control Personnel as having been checked using a Grumman supplied inspection checking fixture. Grumman will make available master gauges if required by the vendor.

8.3 Dimensional tooling is to be provided by the vendor in order to adequately meet all of the hardware requirements as specified herein. The vendor shall indicate what limitations and/or assumptions have been made in providing the tooling section program.

8.4 For a LEM component that is used commonly on the Apollo Command Module or Service Module the same acceptance procedure is required as specified above. However, due to the common usage, it may be necessary for the master gages and/or checking fixtures to originate with a source other than Grumman.

9. LIAISON PROCEDURE

9.1 The following procedure has been arranged to facilitate vendor liaison visits to Grumman, or other Apollo activity.* The vendor shall submit a written agenda and visiting personnel list to Grumman with a copy to the contractor to be visited. Grumman will then review the problems and either authorize a visit or answer the questions directly.

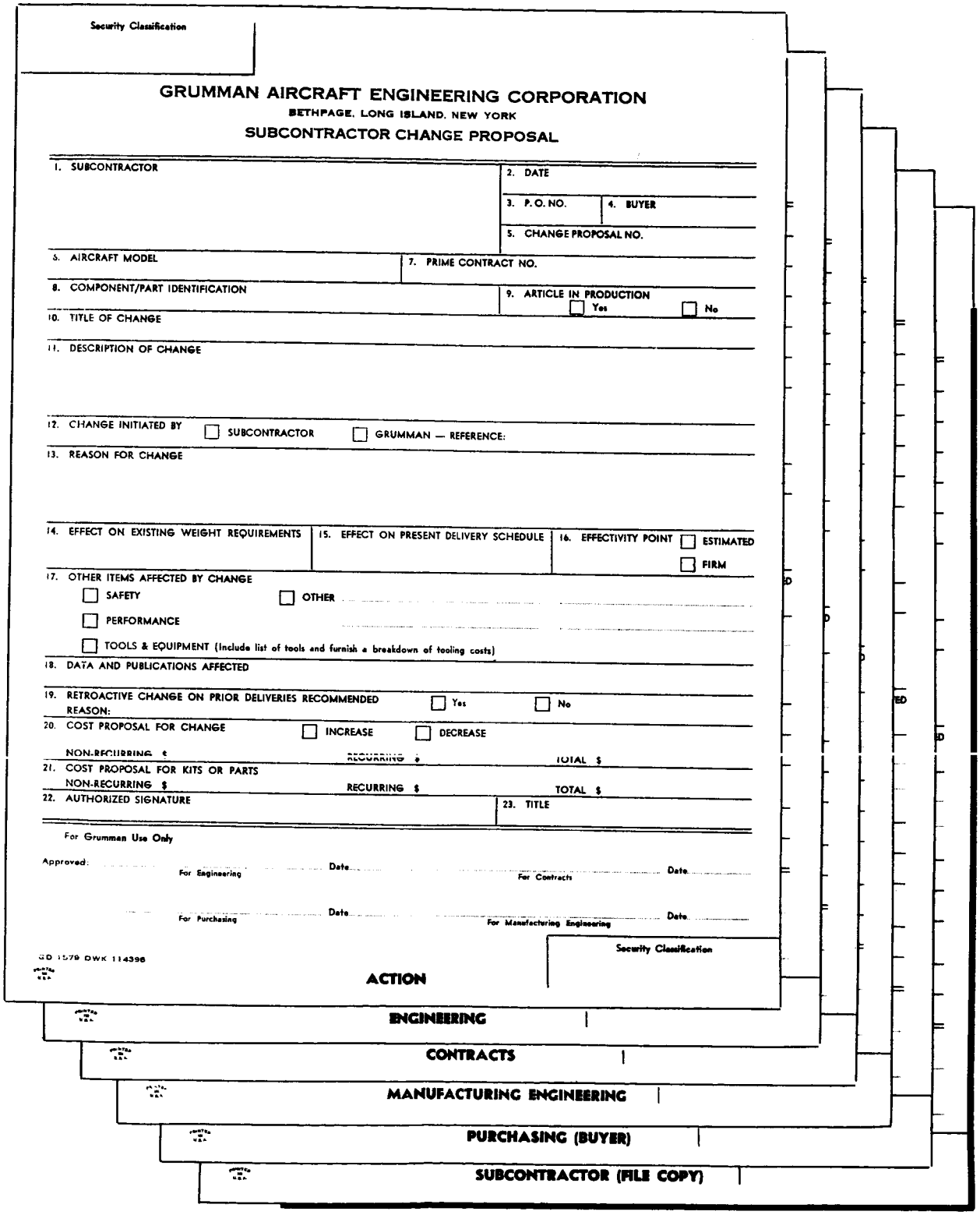
9.2 If direct liaison is authorized by Grumman, a meeting shall be arranged by the vendor. Grumman may desire to attend for information but this is not a requirement of the visit.

9.3 Upon completion of the visit, the vendor requesting the visit shall submit a complete, detailed report to Grumman with a copy to the visited "Activity".* This report shall cover all of the answers to questions presented, and include all other technical information obtained as a result of the visit.

NOTE: *Apollo "activity" means: NASA facility, Apollo contractors or other LEM subcontractors.

10. GRUMMAN ORGANIZATION

The Grumman LEM Program organization is presented in Figure D-2.



Security Classification

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
BETHPAGE, LONG ISLAND, NEW YORK
SUBCONTRACTOR CHANGE PROPOSAL

1. SUBCONTRACTOR
2. DATE
3. P. O. NO.
4. BUYER
5. CHANGE PROPOSAL NO.
6. AIRCRAFT MODEL
7. PRIME CONTRACT NO.
8. COMPONENT/PART IDENTIFICATION
9. ARTICLE IN PRODUCTION ☐ Yes ☐ No
10. TITLE OF CHANGE
11. DESCRIPTION OF CHANGE
12. CHANGE INITIATED BY ☐ SUBCONTRACTOR ☐ GRUMMAN — REFERENCE:
13. REASON FOR CHANGE
14. EFFECT ON EXISTING WEIGHT REQUIREMENTS
15. EFFECT ON PRESENT DELIVERY SCHEDULE
16. EFFECTIVITY POINT ☐ ESTIMATED ☐ FIRM
17. OTHER ITEMS AFFECTED BY CHANGE
☐ SAFETY ☐ OTHER
☐ PERFORMANCE
☐ TOOLS & EQUIPMENT (Include list of tools and furnish a breakdown of tooling costs)
18. DATA AND PUBLICATIONS AFFECTED
19. RETROACTIVE CHANGE ON PRIOR DELIVERIES RECOMMENDED ☐ Yes ☐ No
REASON:
20. COST PROPOSAL FOR CHANGE ☐ INCREASE ☐ DECREASE
NON-RECURRING $ RECURRING $ TOTAL $
21. COST PROPOSAL FOR KITS OR PARTS
NON-RECURRING $ RECURRING $ TOTAL $
22. AUTHORIZED SIGNATURE
23. TITLE

For Grumman Use Only

Approved: For Engineering Date For Contracts Date
For Purchasing Date For Manufacturing Engineering Date

GD 1579 DWK 114396

Security Classification

ACTION

ENGINEERING

CONTRACTS

MANUFACTURING ENGINEERING

PURCHASING (BUYER)

SUBCONTRACTOR (FILE COPY)

FIGURE D-1

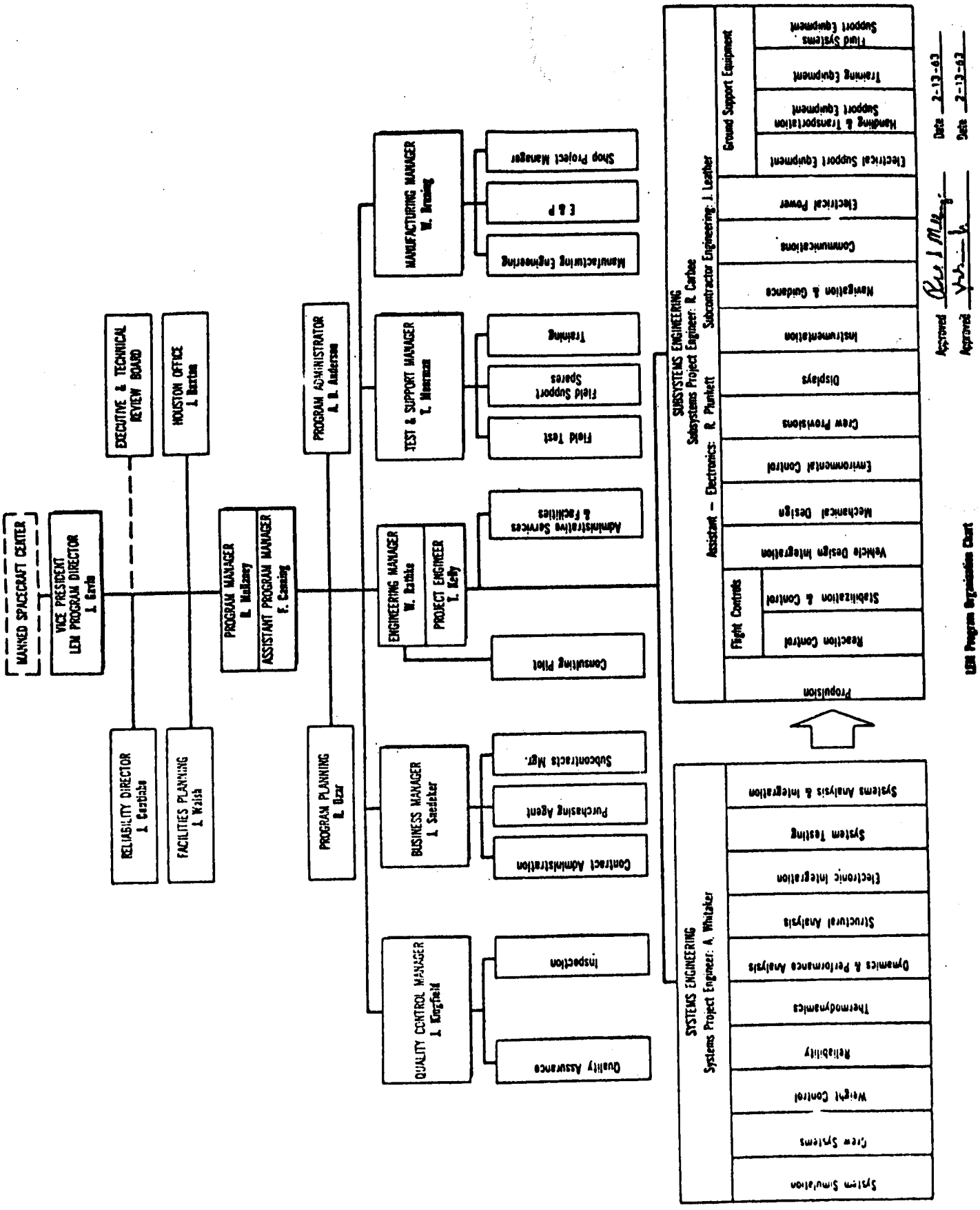

MANNED SPACECRAFT CENTER
VICE PRESIDENT LEM PROGRAM DIRECTOR I. Ertle
EXECUTIVE & TECHNICAL REVIEW BOARD
HOUSTON OFFICE I. Burton
RELIABILITY DIRECTOR I. Costello
FACILITIES PLANNING I. Walsh
PROGRAM MANAGER R. Mallaney
ASSISTANT PROGRAM MANAGER F. Cassing
PROGRAM ADMINISTRATOR A. B. Anderson
PROGRAM PLANNING R. Bizer
ENGINEERING MANAGER W. Rathke
PROJECT ENGINEER T. Kelly
Administrative Services & Facilities
Consulting Pilot
TEST & SUPPORT MANAGER T. Moorman
Training
Field Support Spares
Field Test
MANUFACTURING MANAGER W. Bruning
Shop Project Manager
E & P
Manufacturing Engineering
BUSINESS MANAGER I. Saedeker
Subcontracts Mgr.
Purchasing Agent
Contract Administration
QUALITY CONTROL MANAGER I. Kingfield
Inspection
Quality Assurance
SUBSYSTEMS ENGINEERING
Subsystems Project Engineer: R. Carbee
Assistant – Electronics: R. Plunkett
Subcontractor Engineering: J. Leather
Propulsion
Flight Controls
Reaction Control
Stabilization & Control
Vehicle Design Integration
Mechanical Design
Environmental Control
Crew Provisions
Displays
Instrumentation
Navigation & Guidance
Communications
Electrical Power
Ground Support Equipment
Electrical Support Equipment
Handling & Transportation Support Equipment
Training Equipment
Field Systems Support Equipment
SYSTEMS ENGINEERING
Systems Project Engineer: A. Whitaker
System Simulation
Crew Systems
Weight Control
Reliability
Thermodynamics
Dynamics & Performance Analysis
Structural Analysis
Electronic Integration
System Testing
Systems Analysis & Integration
Approved
Date 2-13-63
Approved
Date 2-13-63
LEM Program Organization Chart

FIGURE D-2

QUALITY CONTROL PROCEDURE: PROCUREMENT

Q.C.P. 2.11

Prepared (or revised) by:
J.E. Stigers
Q. C., Systems and Procedures

Checked by: R.L. Packard

Approved by: B D Evans
Director, Quality Control, GAEC

Original Date: Feb. 5, 1963

Revision No. ____ Date: ____

Page: 1 of 8

TITLE: VENDOR QUALITY CONTROL REQUIREMENTS - SUBSYSTEMS

1. PURPOSE AND SCOPE:

This procedure establishes the quality control requirements to which Vendor shall conform during performance of work on Grumman Aircraft Engineering Corporation Purchase Orders on which it is referenced.

1.1 Any questions concerning this procedure should be directed to to the Grumman Quality Control Department through the cognizant Grumman Buyer.

2. REQUIREMENTS:

2.1 Vendor shall provide and maintain a quality control system meeting all of the requirements of NASA Quality Publications NPC 200-2 - "Quality Program Provisions for Space System Contractors", dated April, 1962, and the supplemental requirements of this procedure.

2.1.1 Exceptions.- NPC 200-2, Section 4, Para. 4.3 through 4.3.4 - Qualification Tests.- Qualification test plans and requirements shall be as specified in the applicable detail performance specification or purchase order.

2.2 For the purposes of this procedure, NPC 200-2 references to "NASA, its designated representative, government or government agency" shall mean Grumman Aircraft Engineering Corporation, except in the following paragraphs:

NPC 200-2, para. 5.3.1b, 5.4, 6.1, 8.1, 8.2, 10.1e

2.3 For the purpose of this procedure, NPC 200-2 references to "contractor" shall mean the individuals, firm, or corporation to whom the purchase order is addressed, and shall be referred to herein as Vendor.

2.4 Vendor's implementation of the requirements of this procedure shall be contained in the program plan required by the applicable Vendor Requirements Document.

Grumman LEM

QUALITY CONTROL PROCEDURE: PROCUREMENT

Q.C.P. No. 2.11

Date: February 5, 1963

TITLE: Vendor Quality Control Requirements - Subsystems

3. SUPPLEMENTAL REQUIREMENTS:

3.1 NPC 200-2 - Section 4 - Design and Development Control shall be supplemented as follows:

Para. 4.3 - Vendor-developed qualification program shall be subject to continued surveillance by Vendor Quality Control.

3.2 NPC 200-2 - Section 7 - Control of Contractor-Fabricated Articles shall be supplemented as follows:

3.2.1 Para. 7.5.1 - Interchangeability Demonstration.- Vendor shall, as required by purchase order, perform the necessary inspections and tests required physically to demonstrate mechanical and functional interchangeability (I & R). Demonstration shall be effected to actual interchange of supplies between assemblies, and shall be witnessed, if required, by Grumman and Government representatives. When the supplies being procured require interchangeability, with Grumman or other vendor-produced coordinating parts, vendor-made or Grumman-designated, Grumman-supplied tooling, interface signal sources, or simulators, shall be "inspected and tested" by Vendor to approved master tools, interface signal sources, or simulators, prior to first piece fabrication or testing.

3.2.2 Para. 7.5.4 - Vendor-used or Vendored processes, equipment, special inspection methods, and personnel certification programs shall require Grumman Quality Control approval.

3.3 NPC 200-2, Section 8 - Nonconforming Materials shall be supplemented as follows:

a. Materials Review.- Supplies found by Vendor to depart from specifications, drawings, or other purchase order requirements, shall be identified as such, and diverted from the normal production channels.

b. Vendor, manufacturing supplies of Grumman design or supplies manufactured to specific requirements of Grumman, shall not exercise Materials Review Board (MRB) authority without written approval of Grumman Quality Control and concurrence of the Government Quality Control Representative at Grumman. In the case of proprietary supplies, the Vendor (Designer) normally retains MRB authority for departures categorized as variations that are not related to Grumman-specified requirements.

c. Vendor may request authority from Grumman Quality Control for the establishment of a formal MRB by:

(1) Establishing and submitting Material Review procedures for Grumman Quality Control approval.

QUALITY CONTROL PROCEDURE: PROCUREMENT

Q.C.P. No. 2.11

Date: February 5, 1963

TITLE: Vendor Quality Control Requirements - Subsystems

3.3c (Continued)

(2) Designating qualified Quality Control and Engineering personnel to act on the MRB, and submitting resumes outlining their education and experience for Grumman approval.

(3) Showing evidence of Government Quality Control approval.

(4) When Vendor is approved for independent MRB action, the following limitations apply:

d. Any changes or additions to the Grumman approved vendor material review procedure or personnel must be submitted for Grumman approval prior to use in connection with Grumman orders. Vendor is not authorized to redelegate MRB authority without prior Grumman Quality Control approval. Vendor shall evaluate and designate Material Review Report discrepancies as deviations, or variations. All discrepancies designated as deviations shall be submitted to Grumman for final approval.

e. Three copies of Material Review Reports shall be submitted to Grumman. Grumman retains the right to review and revise Vendor Review Report dispositions. Material Review Board action shall not be employed by Vendor for standard or easily replaceable parts. Scrap dispositions shall be processed through Material Review Board.

f. If Vendor is not authorized for independent MRB action, discrepant supplies designated for MRB shall be processed in accordance with Grumman Quality Control Procedure 1.7 - and submitted on Grumman Material Review Reports (MRR) Form GDS 2010 for disposition. Vendor shall be advised of Grumman MRB decision.

3.4 NPC 200-2 - Section 10 Inspection Stamps shall be supplemented as follows:

Inspection Identification.- Vendor shall identify the material which has been inspected by stamping or other acceptable methods of marking or identification. Marking methods shall be permanent and not deleterious to the material, or outgas in a space environment, and distinctly different from Grumman/Government Inspection stamps. Where metal impression stamping is approved, stamps shall be of the approved stressless type. Stamping shall be legible and so placed so as to be visible after assembly, (whenever practicable, it should be located near the part number).

Grumman LEM

(Continued)

QUALITY CONTROL PROCEDURE: PROCUREMENT

Q.C.P. No. 2.11

Date: February 5, 1963

TITLE: Vendor Quality Control Requirements - Subsystems

3.4 (Continued)

When inspection process stamps are required by specification(s) and/or purchase order, for processes such as radiography, magnetic particle, ultrasonic inspection, heat treatment, pressure tests, chemical milling, etc., they shall be distinguished from Vendor's regular inspection stamps. Where the inspection process stamp is required, as permanent identification, and this stamp is obliterated by subsequent processing, it shall be transferred to accompanying traveler, route card, etc., and later reapplied to the item.

3.5 NPC 200-2, Section 12 - Statistical Planning, Analysis and Quality Control shall be supplemented as follows:

Para. 12.3 - Any inspection sampling procedure (less than 100% inspection) used by Vendor to determine acceptability of supplies to be furnished Grumman shall require Grumman Quality Control approval prior to use, unless otherwise specified by Grumman drawings and/or design performance/control specifications. Approval of acceptance sampling plans shall be based on submittal of the following information:

a. Organization for statistical quality control.

b. Procedures for administration of statistical quality control program.

c. Sampling plans with the selected acceptable quality levels, (AQL's) and areas of intended application (parts, paperwork, process controls, etc.)

3.6 NPC 200-2, Section 14 - Data Reporting and Corrective Action:- shall be supplemented as follows:

a. Vendor inspection records shall be available for Grumman and Government review. Such records shall be retained by the Vendor for a period of three years after final payment of the purchase order, unless otherwise specified.

b. Vendor failure to include the inspection documentation as required by purchase order, i.e., test reports, certification, etc., with the shipment to Grumman shall result in technical rejection of the shipment upon receipt at Grumman.

3.7 NPC 200-2, Appendix B - Quality Program Documentation:

The following documentation, due dates, quantities and destinations, shall be as specified in the applicable Vendor Requirements Documents.

QUALITY CONTROL PROCEDURE: PROCUREMENT

Q.C.P. No. 2.11

Date: February 5, 1963

TITLE: Vendor Quality Control Requirements - Subsystems

3.7 (Continued)

Quality Plan
Acceptance Test Data Sheets
Special Sampling Plans, Application of Sampling
Results of Special Measuring and Test Equipment Evaluation
Monthly Quality Status Report
Quarterly Summaries of Quality Control Performance Audits
Test and Inspection Procedures
Process Control Procedures
Storage Procedures for End Items
End Item (Acceptance) Test Plan
End Item Test and Inspection Procedures
End Item Narrative Report
Material Review Documentation
Configuration Control Procedures

3.8 Configuration Control.- Vendor shall establish configuration control procedures to assure:

3.8.1 That all materials are identified and that fabricated articles are traceable and identifiable to the material from which they were fabricated.

3.8.2 That all parts and end items are of the proper configuration and that all approved configuration changes are incorporated at the specified effectivity points.

3.9 Returned Purchased Material.- When material is returned by Grumman to Vendor because of failure to comply with purchase order requirements, Vendor shall adhere to the instructions specified on the Grumman Rejection Notice Form QCD-51.

3.9.1 In the event Vendor is unable to verify the discrepant condition as stated by Grumman, or disclaims responsibility for a verified discrepant condition, or acknowledges partial responsibility only for the discrepant condition, it shall be the responsibility of Vendor to immediately advise the Grumman Purchasing Department, Attention: appropriate Buyer, of the fact that exception is being taken to the rejection. The letter of exception shall make full reference to applicable documents, and shall be specific in defining the area of exception. Further, Vendor is required to retain in his possession the material in question pending disposition by Grumman.

3.9.2 In all cases when returning material to Grumman, Vendor shall indicate on his shipping documents that the material is being returned as "repaired", "replaced", or "returned as is" and reference the Grumman Rejection Notice Number.

3.9.3 When specifically required by the Rejection Notice or Quality Control Report, a full report based on the detailed analysis of the failure or discrepancy shall be submitted by Vendor. (Vendor's report shall bear evidence of Vendor's quality control concurrence). Such report shall indicate the probable cause of failure, method of correction or removal of the discrepancy or defect, corrective action taken to preclude the recurrence of such defect(s), on subsequent items and point of effectivity of such corrective action.

3.9.4 Vendor shall provide the cognizant Grumman Inspector the copy of the Rejection Notice marked "Government Inspector" on all rejection notices for Government source-inspected items.

3.10 Vendor Rework at Grumman.- Vendor-supplied replacement parts used to accomplish rework at Grumman, other than AN or MS parts or research and development electronic equipment shall be accompanied by objective evidence of Vendor acceptance inspection, and when required by the purchase order, evidence of Government source inspection. All Vendor rework at Grumman shall be coordinated with Grumman Quality Control prior to commencement and shall be subject to Grumman inspection.

3.11 Grumman Quality Control shall maintain surveillance over Vendor Quality Control System by resident and/or itinerant Quality Control representatives who shall be responsible for:

3.11.1 Initial and periodic surveying of Vendor, and when applicable, his supplier's facilities, quality control system(s), manufacturing and processing controls to determine Vendor's capability and effectiveness in producing supplies in accordance with the requirements of this procedure, the purchase order, and the referenced Grumman data, and the Vendor's approved quality program plan.

3.11.2 Performing and/or witnessing conformity inspections and tests at advantageous points in the manufacturing and assembly process to insure Vendor's continued ability to produce quality supplies. Whenever problems or deficiencies exist in the quality of the supplies, determining and advising Vendors of the extent of additional inspection and test that may be required.

3.11.3 Performing detailed first-article inspection when required by the purchase order or the applicable procurement specification. Inspection may be performed on the first or one of the subsequent articles predicated on purchase order requirements and the scheduled visits of the Grumman Quality Control representative.

3.11.4 Insuring that Vendors are properly completing and maintaining, available for review, all records of inspection and tests performed, including incoming material test reports, certification and processing tests, when required.

3.11.5 Assisting Vendors in the interpretation of the quality control requirements of the purchase orders.

3.11.6 Advising Vendor's Quality Control Manager/Chief Inspector of unsatisfactory conditions which have or will affect product quality, and therefore require prompt corrective measures.

3.11.7 Acting as liaison between Vendor and departments of Grumman, (other than Quality Control) in matters which affect the quality of supplies.

3.11.8 Performing (when directed) Grumman source inspection on purchase orders which call for direct shipments to the Government or other Subcontractors of Grumman.

3.11.9 Witness qualification and acceptance testing.

3.11.10 Participating in termination actions and tooling inventories when requested by the Grumman Accounting Department.

3.12 DEFINITIONS:

The following is a list of selected terms and their meaning as related to the requirements of this procedure. (NPC 200-2 except as specified in 2.2. of this procedure).

3.12.1 Deficiencies.- A general term covering any defect, failure, discrepancy, or other lack of conformance to specification.

3.12.2 Deviations.- A departure from the drawing, specification, or purchase order which may adversely affect safety, performance, weight, service life, or interchangeability of this article.

3.12.3 Grumman Quality Control Representative.- A representative of the Grumman Quality Control Department, i.e., Inspection, Quality Assurance, Tool Inspection, Quality Control Laboratory.

3.12.4 Government Inspector.- The representative of that government agency, assigned the responsibility for inspection and acceptance of supplies produced for the Government.

Grumman LEM

3.12.5 Inspection.- The examination (including testing) of supplies and services (including, when appropriate, raw materials, components, and intermediate assemblies) to determine whether the supplies and services conform to requirements, which include applicable drawings, specifications, and purchase descriptions.

3.12.6 Letter of Exception.- A Vendor letter taking exception to Grumman's rejection of their supplies.

3.12.7 Proprietary.- Designation of ownership of a design or a material or a process of manufacture, originated by or peculiarly within the knowledge of the owner thereof, and those in privity with him, and which is protected by secrecy.

3.12.8 Rejection Notice.- A notice (QCD Form 51) formally rejecting Vendor supplies.

3.12.9 Scrap.- Detail parts, assemblies, components, that have been rejected and are irreparable due to spoilage, damage, or for other authorized reasons.

3.12.10 Supplies.- A general term used to define material, parts, components, intermediate assemblies, equipment, and end products, whichever is applicable to the Grumman purchase order.

3.12.11 Technical Rejection.- A modified rejection notice which does not reject and return material, but does debit the Vendor's account. Used where documentation or Government Source Inspection requirements, as specified by the purchase order, have not been accomplished.

3.12.12 Variation.- A departure other than a deviation.

3.12.13 Vendor.- The term "Vendor" includes the term "Subcontractor" and means the individual, firm, or corporation to whom the purchase order is addressed and who is to furnish to Grumman the supplies and/or services specified thereon.

Grumman L E M

VENDOR REQUIREMENTS

ELECTRICAL POWER - FUEL CELL ASSEMBLY

FOR

LUNAR EXCURSION MODULE

LVR-390-2

SECTION E DOCUMENTATION

SECTION E

DOCUMENTATION

A summary of all documentation requirements is presented in this section. A schedule indicating the items of documentation, delivery dates, quantities, documentation type, form and number of copies is listed in Table I attached.

TABLE OF CONTENTS

1. GENERAL. - The Vendor shall provide documentation throughout the life of the purchase order in accordance with the requirements of the following paragraphs. The documentation requirements specified shall not be altered as a result of a make or buy decision; e.g., the Vendor shall be responsible for the specifications for the items he makes as well as those he buys. Grumman reserves the right to specify the format and content of the individual documents listed herein. Where a conflict exists between the requirements of this document and the referenced specifications or documents, the requirements of this document will apply. All data submitted shall be in reproducible form and accompanied by the specified copies indicated in Table I. For the purpose of this requirement, reproducibles shall be diazo sepias or equivalent.

1.1 Classification. - Data required shall be of three categories. Type I data shall be submitted to Grumman for approval. Implementation of Type I documentation shall not proceed until after approval by Grumman or until 30 days after submittal, whichever is earlier. Type II data shall be submitted for coordination, surveillance, information, review, and/or management control. Type III data shall be retained by the Vendor and submitted to Grumman only upon request. Insofar as practicable, the Vendor's own internal documents shall be utilized to meet the requirements specified herein, e.g., internal documents shall not be retyped and printed on more expensive paper prior to submission.

1.2 Data Delivery. - Data shall be delivered to Grumman in accordance with the schedule presented in Table I. All documentation delivered shall be clearly marked with the paragraph number requiring such delivery. If the document to be submitted is Type I, it shall be marked "Preliminary - Grumman Approval Pending." All documentation shall be delivered to:

Grumman Aircraft Engineering Corp.
LEM Program, Data Management
Bethpage, New York

Attn:

2. APPLICABLE DOCUMENTS. - The following documents, of the issue in effect as of 14 January 1963, form a part of this section to the extent specified herein:

Document Number	Title
	NASA-PERT and Companion Cost System Handbook, dated 30 October 1962
NPC 200-2	Quality Assurance Provisions for Space System Contractors, dated April 1962
MIL-S-6644A	Specification, Equipment, Contractor Prepared, Instructions for the Preparation of
MIL-STD-15	Electrical and Electronic Symbols
MIL-STD-16B	Electrical and Electronic Reference Designations
MIL-STD-806B	Graphical Symbols for Logic Diagrams
MIL-STD-12	Abbreviations for use on Drawings and in Technical-Type Publications
QCP 2.11	Grumman Quality Control Procedure
ME 224	Grumman Tool Reporting Form
MIL-STD-756	Reliability of Weapons Systems, Procedure For Predictions and Reporting Predictions of (10 October 1962)
MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment
LSP-390-2	Fuel Cell Assembly - Electrical Power, Design Control Specification for

3. PROGRAM PLANNING DOCUMENT. -

3.1 A sectionalized program planning document shall be prepared containing plans as follows:

Section I - Program Plan

Section II - Facilities Plan

Section III - Test Plan

Section IV - Manufacturing Plan

Section V - Support Plan

Section VI - Training Plan

Section VII - Reliability Plan

Section VIII - Quality Control Plan

Section IX - Engineering Plan

3.1.1 Section I - Program Plan. - This plan shall summarize the following:

(a) Management and organization functions.

(b) Description of controls covering costs, changes, liaison, manufacturing, etc.

(c) Description of the product and its design, development, and integrated functional operation.

(d) Manpower requirements for performance of the project.

(e) Summaries of each of the plans contained in Section II through IX.

3.1.2 Section II - Facilities Plan. - This plan shall cover the complete requirements for providing and/or utilizing facilities and shall identify those that are government furnished. Manufacturing, test, storage, and all other facility requirements shall be described in detail, including any necessary modifications to existing facilities. Schedules showing required availability and modification dates, and plans for accomplishing necessary design and construction shall be included.

3.1.3 Section III - Test Plan. - This plan shall contain a general discussion of the test program for the equipment including topics as follows:

(a) Definition of test article.

(b) Purpose of test, including category, e.g., development qualification, acceptance, reliability, or operational, and test objectives.

(c) Test facility, including name, location, and description of support test equipment.

(d) Test descriptions, including test set-up, general procedures, and environments.

(e) Test constraints, stating prerequisites for specified tests, such as, "successful completion of test XYZ," or if none, so state.

(f) Test schedules providing chronological chart of milestones of test program.

3.1.4 Section IV - Manufacturing Plan. - This plan shall discuss such items as plans, schedules, methods, controls, and required tooling.

3.1.5 Section V - Support and Maintenance Plan. - The support plan shall describe the Vendor's support of operations including, but not limited to, the following:

(a) Description of anticipated equipment maintenance requirements.

(b) Field engineering personnel requirements.

(c) Equipment transportation requirements.

(d) Required ground support equipment.

(e) Method of spares selection and control.

(f) Method of compliance with support manuals requirements.

(g) Packaging and storage requirements including containers.

3.1.6 Section VI - Training Plan. - This plan shall cover training of ground operations and maintenance personnel, and shall specify training facilities, equipment aids, materials, manuals, schedules, etc. The plan shall be supported by analyses of the tasks required of each type of personnel to be trained.

3.1.7 Section VII - Reliability Plan. - This plan shall describe the Vendor's program for implementing a reliability and maintainability control program for the purpose of exercising adequate control over all key operations during the design, development, production and delivery phases of the purchase order, and to assure that the reliability/maintainability requirements of the applicable equipment specification are met in the delivered product. The reliability program plan shall contain a simplified organization chart and shall clearly describe how the plan will assure that, at each monitoring point, due consideration has been given to reliability factors and that all provisions of this specification are complied with. The Vendor's reliability program plan shall include plans for training of engineering as well as manufacturing personnel. These plans shall differentiate between necessary skills now possessed by personnel, and those which must be developed specifically for this program. In addition the reliability program plan shall describe the procedure for the analysis of stress-to-failure data based on the Weibull distribution applications as outlined in the Appendix, paragraph 15.

3.1.8 Section VIII - Quality Plan. - The Vendor shall prepare a quality plan in accordance with the provisions of paragraph 3.1 of NPC 200-2 and QCP 2.11. Quality plan format shall be prepared in accordance with NPC 200-2 section headings.

3.1.9 Section IX - Engineering Plan. - The Vendor shall prepare a design and development engineering plan that describes in detail the manner in which compliance with the requirements of Grumman Specification LSP-390-2 shall be accomplished.

4. DRAWINGS AND SPECIFICATIONS. -

4.1 GENERAL. - The Vendor, using MIL-S-6644A as a guide, shall prepare and submit to Grumman for approval all component specifications and drawings required to manage the design, fabrication and quality assurance in an efficient manner. All releases prior to qualification will be submitted to Grumman for information. Prior to commencing the preparation of any of these documents, the Vendor shall prepare and submit to Grumman for approval a specification and drawing list.

4.2 Drawings. - The Vendor shall submit to Grumman the drawings, associated data, and all revisions thereto, requested in the Fuel Cell Assembly Design Data Report. For the purpose of this requirement, associated data is defined as all data referenced on drawings where such data is not requested elsewhere in this document. These drawings and associated data shall be prepared using the Vendor's internal systems and shall conform to high quality commercial standards. The drawings and data shall be submitted in reproducible form. For the purpose of this requirement, a reproducible is defined as a diazo sepia or equivalent. The intended use of these drawings and data is for surveillance, information, and design review and is classified Type II documentation. In addition to the foregoing, certain selected drawings, such as major assemblies, sectional views, installation views, etc., will be classified Type I documentation and must be submitted to Grumman for approval prior to release. To establish those drawings to be classified Type I, the Vendor is to prepare and submit a drawing numbering tree showing drawing titles and numbers to be assigned.

4.2.1 Drawings - Special Test and Special Handling Equipment. - The requirements of paragraph 4.2 also apply to special test and special handling equipment.

4.2.2 Drawing Revisions. - Class I revisions, as defined below, shall not be incorporated in the design unless the Vendor receives prior approval from Grumman. For Class II revisions, as defined below, the Vendor shall maintain and submit a list of all such revisions. This list shall identify revised items and shall include a brief description of the revision. All revisions (Class I and Class II) shall be outlined on the drawing(s) and resubmitted to Grumman as released.

4.2.2.1 Class I Revisions - Definition of. - All proposed engineering changes in accepted and/or unaccepted complete articles, assemblies, subassemblies or parts shall be designated as proposed

4.2.2.1 (Continued)

Class I changes in design whenever one or more of the following is affected:

(a) Purchase order specification requirements.

(b) Purchase order cost/fee, weight, guarantees, or delivery schedule.

(c) Performance, stability, reliability, durability or maintainability.

(d) Interchangeability of complete article, assembly or component thereof.

(e) Safety.

(f) Electrical interference to communications-electronic equipment or electromagnetic radiation hazards.

(g) GFE/Support Equipment.

(h) Preset adjustments or preset schedules to the extent that (1) new identification must be assigned, or (2) operating limits are affected.

4.2.2.2 Class II Revisions - Definition of. - All other engineering changes shall be designated as a Class II change. Class II changes shall not invoke changes in part numbers of a procurable part.

4.2.2.3 Drawing, Specification and Documentation List. - The Vendor shall provide to Grumman a drawing, specification, and documentation list which presents all assigned numbers, titles, release dates, effectivities, and a brief description of each entry. The entries for drawings and drawing changes shall include the next assembly numbers and next assembly titles. Periodic revisions shall be cumulative with all additions coded in a merged list and also printed separately in the front of the list. The list shall cover all documentation submitted to the Vendor by his subcontracts in a separate section for each of his subcontractors.

4.2.2.4 Drawing, Specification and Documentation List - Special Test and Handling Equipment. - A separate list, not a part of that furnished under the requirements of paragraph 5.6.3, shall be provided for special test and special handling equipment. This list is to be similar in format to that furnished in compliance with paragraph 5.6.3.

4.2.2.5 Material Specifications. - The Vendor shall submit a list of procurement specifications applicable to the materials used in the manufacture of the fuel cell assembly. Where a Government or industry accepted specification is not used, the Vendor shall submit the manufacturer's name or numerical designation for the material.

5. Fuel Cell Assembly Design Data Report. - The Vendor shall provide a Fuel Cell Design Data Report. This report shall be the Vendor description of the equipment required to satisfy Grumman Specification LSP-390-2. The Fuel Cell Assembly Design Data Report shall consist of but not be limited to the following:

5.1 General Description. - This section shall contain a description of the salient features of the fuel cell assembly.

Fuel Cell Assembly Rating. - This section shall contain all of the nominal ratings of the fuel cell assembly, where applicable:

(a) Power (maximum).

(b) Voltage (at maximum power).

(c) Oxygen pressure.

(d) Hydrogen pressure.

(e) Operating temperature.

(f) Nitrogen pressure.

(g) ΔP between hydrogen and water.

(h) ΔP between hydrogen and oxygen.

(i) Reactant consumption rate vs. power.

5.2 Performance. - Sea level, vacuum and zero gravity performance characteristics of the fuel cell assembly designed in accordance with LSP-390-2, shall be presented as follows:

(a) Power vs. time.

(b) Power vs. voltage.

(c) Oxygen consumption rate vs. power.

(d) Hydrogen consumption rate vs. power.

(e) Total reactant (including purging and venting) consumption vs. power.

5.2 (Continued)

(f) Heat rejected vs. electrical power.

(g) Transient response to step load. Voltage vs. time.

(h) Short circuit characteristics.

(i) Voltage vs. current.

(j) FCA efficiency vs power.

(k) Transient characteristics.

(1) Current vs. time for all power changes as shown in figure 7, LSP 390-2 including short circuit.

(2) Voltage vs. time for the removal of the above conditions.

(l) Starting. - Description of start cycle in LEM vehicle prior to launch. Description of start cycle from standby conditions. Description of start cycle for ground test if different.

(m) Shutdown. - Description of shutdown cycle from standby and normal operation.

(n) Preflight Check. - Describe the provisions for preflight check out and list the test equipment required.

(o) Inlet Conditions. - Describe reactant inlet requirements for normal operation and starting.

5.3 Weight/Status Report. - This report shall include maximum weight, changes, reasons for changes, past status and current status. A detail breakdown of the current weight shall indicate that the status of each component is either estimated, calculated or actual. The format used shall be as approved by Grumman. In addition, the following data shall also be included in the report:

(a) The center of gravity of all components shall be noted within $\pm$.1 inch and the reference axis system shall be designated.

5.3 (Continued)

(b) The moments and products of inertia of all components about the component c.g. shall be noted with respect to their own geometric axis.

(c) Potential weight changes shall be listed separately with brief notes on magnitude, reason for change and other pertinent information. This listing is for trending purposes and should point up areas of possible growth or reduction for which data or requirements are presently too vague for definite appraisal.

Weight. - Table of component weights, fuel cell assembly, inertias and description of method of ascertaining inertias.

5.4 Parts and Materials List. - A complete list of parts and materials used in fabrication of the fuel cell assembly. This list shall be furnished prior to qualification test and kept current.

5.5 Drawings. -

(a) The fuel cell assembly drawings - major component assembly drawings and all associated data.

(b) Reactant flow diagram through FCA.

(c) Electrical system diagram.

(d) Control system diagram.

(e) Instrumentation system diagram.

(f) Connection diagrams (pictorial).

(1) Electrical
(2) Reactant
(3) Other

5.6 ELECTRICAL POWER UTILIZATION ANALYSIS

The Vendor shall provide an Electrical Power Utilization Analysis which defines the quantity and characteristics of the electrical input power necessary to properly operate the (fuel cell assembly) in accordance with Performance Specification on LSP-390-2. The analysis shall also define the physical provisions made with the

5.6 (Continued)

equipment to condition the input power. (Power circuit design, weight and volume).

The E.P.U.A. shall consider operating voltage(s), frequency(s), tolerances, power consumption, reliability, weight, design, performance, efficiency, duty cycle and electromagnetic interference. Prime consideration shall be given to operating directly with the electrical power characteristics indicated in the design specification. Reasons for approaches taken in each of the above areas shall be covered in detail in the report. Completed form LSK-390-1027 shall form a part of the report.

The data shall be continuously monitored and updated (re-issued at three-month intervals). Design changes involving the content of the report must have prior Grumman approval before incorporation.

Data provided in the initial issuance of the analysis shall be based upon preliminary design information. Subsequent data shall be based upon actual equipment measurements taken from initially received components, revised as component design progresses. Final data consists of measurements taken from equipment provided for qualification testing.

5.7 Thermal Design. - The Vendor shall submit thermal design data for the FCA during the design development. This data shall be subject to the review and approval of Grumman and shall be prepared in three sections covering the three major phases of the thermal design. The three sections shall be as follows:

(a) The definition of the environment problem.

(b) The analytical solution of the environment problem.

(c) The physical design.

5.7.1 Definition of Environment Problem. - This section shall contain a listing and definition of all the FCA environmental control requirements and operating limitations that have a direct bearing on the thermal design of the FCA. It shall include at least the following information for the FCA:

(a) Heat dissipation during normal, peak, standby and transient operation.

(b) Coolant requirements.

5.7.1 (Continued)

(c) Pressurization requirements.

(d) Low and high temperature limitations, steady state and transient.

(e) Heat transfer analytical model and justification for its selection.

5.7.2 Analytical Solution of Environment Problem. - The results of this analysis shall be a complete definition of environmental control design parameters and overall FCA characteristics which will provide an optimum solution to the problem of controlling the temperature of the FCA, through the various operations performed by the spacecraft during its mission. The temperature envelopes shown must be consistent with the reliability data furnished for the FCA. The Vendor shall also include a description of the techniques used in reducing the penalty of thermal control on the vehicle performance.

5.7.3 The Physical Design. - This section shall show in detail how the results of the analytical solution are translated into hardware.

5.7.4 Supplemental Information. - In addition to the above reports the Vendor shall be required to supply supplemental information to Grumman. The information to be furnished shall include at least the following items:

5.7.4.1 The location of all heat dissipating elements in the package whose individual dissipations are 1% or more of the total equipment dissipation.

5.7.4.2 The power levels of all heat dissipating elements in the package.

5.7.4.3 The variation of the units electrical efficiency and hence thermal dissipation with temperature over the qualification test range.

5.7.4.4 Drawings showing in detail the dimensions of the package and the materials used both internally and externally.

5.7.4.5 The locations of contact resistances in the thermal paths within the package and the characteristics of the material being used to fill these contacts.

5.8 Structural Analysis. - The structural analysis shall include at least the following information:

(a) A criteria statement including factors of safety and selection of critical conditions.

(b) A summary of applied loads, shock, vibration and temperatures.

(c) A description of analysis methods.

(d) A justification of materials selected.

(e) A stress analysis of internal load distribution.

(f) A determination of strength and statement of analysis margins.

(g) A statement of operating restrictions.

This analysis is to be submitted in sections as each logical subdivision of work is completed. The complete analysis is required prior to commencement of qualification testing.

6. Detail Test Plan. - In advance of any component or fuel cell development qualification, or acceptance test, the Vendor shall submit, in accordance with Table I, a detailed test plan to Grumman for approval. The test plan shall include, but not be limited to the following major topics:

(a) Purpose of test. State first, second, and third order objectives.

(b) Name and location of test facility.

(c) Detailed description of the environmental test equipment including the name, model, manufacturer serial number, accuracy, and the characteristics of the equipment.

(d) Description of test articles with drawings or sketches to identify the tested part.

(e) Description of test set-up with drawings or sketches of test fixtures showing all specimen attachment points.

(f) Detailed description of test procedures and conditions including but not limited to:

(1) Method of attaining, maintaining and testing at the specified environmental conditions.

(2) Operational and performance procedures for demonstrating the equipment's performance for all design characteristics, before, during and after exposure, including a section defining failure criteria for the particular equipment under test.

(3) Instrumentation Measurement List. Vendor shall provide an Instrumentation Measurement List. The list shall be prepared in the format of the on page E- , listing all instruments used in the test.

(4) Calibration Procedure. All procedures and equipment used in calibrating the instrumentation will be documented and submitted to Grumman for approval as part of test plan. Calibration data and curves shall be maintained in the Vendor records and supplied in the Test Report.

6. (Continued)

(5) Procedure to be followed in the event a failure is encountered.

(6) Sample data sheet.

(g) Test constraint. State prerequisites for beginning test such as, "successful attainment of the first and second order objectives of test XYZ," or if none, so state.

6.1 Reliability Assurance Plan. - The Vendor shall include in the detailed development and qualification test plans the method by which the required Reliability Assurance is to be confirmed. The test plan shall list and describe the portions applicable to Reliability Assurance, the manner in which they are integrated with other test requirements, and the method by which the applicable test data is combined for Reliability Assurance Analysis. In addition test plans shall include but not be limited to the following reliability requirements:

(a) The test conditions and operating parameters selected for the Reliability Boundary (RB) when applicable, the basis for this selection, and the method of application.

(b) The applicable "mission time" for the test.

(c) The critical stresses and operating parameters chosen for stress testing to failure and the reasons for the selection.

(d) The maximum practical stress level and the increments chosen for the stress test to failure.

(e) The predicted failure mode.

(f) The analysis techniques to be employed to show compliance with Reliability Assurance requirements.

(g) The environmental stress level for establishing a curtailed test criteria.

7. TEST DATA AND REPORTS. -

7.1 Logging of Official Test Data. - During the course of the development, qualification, and acceptance testing the Vendor shall enter all data pertinent to the test being performed, the item(s) under test, or both into an official log. A separate log book shall be kept for each test item, and this log book shall be the sole document containing the official data on the program in chronological order. The official log book(s) shall provide for the signature by a designated Grumman witness.

7.2 Report Requirements - Summary. - Upon completion of any development, qualification, or acceptance test, the Vendor shall submit in accordance with Table I, a summary of test results to Grumman for approval. These reports shall include but not be limited to the following major topics:

7.2.1 Statement as to whether the test item passed or failed.

7.2.2 Description of deviations from test plan, if any.

7.2.3 If any failures occur, anticipated remedial steps shall be indicated. (see paragraph 13.(f)(2)).

7.2.4 If retest is required, a statement shall be included of the next anticipated test date.

7.2.5 Certification by Grumman designated representative as to the proper conduct and factual accuracy of the test.

7.2.6 Summary Data Sheets. -

7.2.6.1 Limits - Performance limits and bench testing limits shall be superimposed on all summary curves. Performance limits shall be defined as the envelope of the curves which will give the FCA performance which is specified in the test plan.

7.2.6.2 Title Block - Each curve sheet or data plot shall contain the following information in a title block:

1. Title (of summary).
2. Component (nomenclature).
3. Manufacturer (of component).
4. Part No. (of component).

7.2.6.2 (Continued)

5. Serial No. (of component).
6. Test Nos. (of original data sheets or curves from which summary curves are plotted).
7. Prepared by; approved by.
8. Date.
9. Purchase Order No.
10. Report No.
11. Page No.
12. Figure No.
13. Vendor.
14. Testing activity.
15. Used on.

Data Block. - Test constants and other test data not recorded in the title block shall be recorded in a separate block.

7.3 Report Requirements - Final. - Upon completion of development, qualification, or acceptance test, the Vendor shall submit in accordance with Table I, a report covering the results of test to Grumman for approval. These reports shall include but not be limited to the following major topics:

7.3.1 Purpose of Test. -

7.3.2 Reference to Test Plan. -

7.3.3 Concise Summary of Results. -

7.3.4 Description of Test Set-Up Including Photos. -

7.3.5 Test Procedures Followed. - Indicate clearly and specifically any deviations from the test plan with justification for such deviation.

7.3.6 Description of Test Article. - Include sufficient information on marking system to positively identify the tested part.

7.3.7 Results of Test. - A detailed discussion of all results obtained from the test, and in particular a statement showing how the objectives of the test, as stated in the test plan, have been achieved.

7.3.8 Recommendations. - A statement precisely stating the Vendor's recommendations for the use of the tested part and for any other action to be taken as a result of the test.

7.3.9 Log of Test. - A copy of the official log book(s) as written shall be included as part of the report requirements.

7.3.10 FCA Data. - Copies of reduced data shall be furnished in all cases. Reduced data shall include but not be limited to the following:

(a) Power vs. time.

(b) Oxygen pressure vs. power.

(c) Hydrogen pressure vs. power.

(d) Power vs. voltage.

(e) Oxygen consumption rate vs. power.

(f) Hydrogen consumption rate vs. power.

(g) Total reactant consumption rate (including venting and purging) vs. power.

(h) Heat rejected vs. power.

(i) Fuel cell temperature vs. time.

(j) Fuel cell temperature vs. power.

(k) Voltage vs. current.

(l) Chemical energy present in consumed reactants/ electrical energy out ratio vs. power.

(m) Transient characteristics.

(1) Current vs. time for all power changes as shown in figure 4, LSP 390-2, including short circuit.

(2) Voltage vs. time for the removal of the above conditions.

7.3.10.1 WEIGHT. -

7.3.10.2 STATIC LEAKAGE - SCC/hr. -

7.3.10.3 ENVIRONMENTAL AND STRUCTURAL TEST DATA. -

7.3.10.4 RADIO INTERFERENCE TEST - RESULTS. -

7.4 Reliability Assurance Report. - The Vendor shall submit the analysis to show compliance with reliability assurance requirements as part of the Development Test Report and the Qualification Test Report. The Qualification Test Report shall also include the results of the development test use in substantiating that the reliability assurance requirements of the FCA have been met.

7.5 Qualification Status List. - The Vendor shall prepare and maintain a status list showing the planned and completed qualification of each part, component, and assembly for which he is responsible. The basis for qualification of those parts and components for which LEM qualification tests are not required shall be shown. Where qualification is based on tests conducted under the Apollo Program, the date of such tests and reference to the detailed test reports shall be shown. The list will be used to notify Grumman in advance of qualification tests on LEM assemblies in order that cognizant Grumman technical representatives may witness such tests if desired. On completion of such testing, similar notification of results shall be provdied in the form of revisions to the list which will include identification of test, date accomplished, explanation, and certification results.

7.6 Material Test Data. - The Vendor shall substantiate the selection of all materials used in the fuel cell assembly by submittal of test data. Tests shall be conducted under simulated service conditions expected during the life of the unit in addition to those environmental conditions listed in Grumman Specification LSP-390-2.

7.7 General Test Reports and Data. - Reports and data on all required test not otherwise provided for herein shall be submitted by the Vendor.

8. Reliability Report. - This report shall be submitted to Grumman for approval and shall contain preliminary information as outlined below. It shall include the following:

(a) Initial Reliability Apportionment of the detail specification requirement for the equipment and its various components.

(b) Reliability estimates of the equipment, including the preliminary Parts & Components Reliability Data List.

(c) Configuration Analysis consistent with the status of the design effort.

(d) Preliminary Failure Effect Analysis consistent with the status of the design effort.

8.1 Configuration and Circuit Analyses. -

8.1.1 Configuration Analyses (Trade-off Studies). - Configuration Analyses shall be prepared to assist the design engineers in making optimum decisions before a design is frozen. A configuration analysis shall compare alternate configurations, logical designs, functional arrangements, or any other schemes affecting the reliability of the equipment in such a manner as to assist the designer in selecting the optimum design. A configuration analysis completed after a design decision is made serves no purpose. A systematic effort shall be made to consider all possible schemes and arrangements before a decision is made. For each configuration, the significant parameters involved in the particular circumstances shall be identified. These parameters usually involve considerations such as weight, cost, performance, life, maintainability, reliability, schedules, fail-safe features, etc. The various configurations under consideration usually consist of different arrangements of components or functions which all yield the same result in the main operating mode, but which may involve different degrees of redundancy and different degraded modes of operation. The significant effect of each parameter shall be evaluated quantitatively by suitable figures of merit. Normally, figures of merit are numbers which are not exact measures of parameters, but rather relative values indicating the importance of a parameter within the scope of a particular investigation for the purpose of establishing the optimum trade-offs and thus arriving at the best configuration.

8.1.2 Circuit Analysis. - Where applicable, an analysis shall be conducted during the design phase to assure optimum application of component parts. The analysis shall at least indicate the following data for each part used in each circuit or subassembly of the equipment: (reference paragraph 13.(f)(3)).

(a) Part Performance ratings at the application environment.

(b) Loadings.

(c) Environmental conditions expected.

(d) Derating factors at the given environmental conditions.

(e) Expected failure rates at the given environmental conditions and derating factors.

(f) Symptoms and consequences of the mode of failure on the circuit and the mission capability of the system.

(g) Compensating provisions inherent in the design or alternate operating modes.

(h) Probability of occurrence of each circuit mode of failure based on the summation of the contributing component part failure rates.

The analysis shall ascertain that all component parts and modules used in more than one application are allotted location code (part reference designator) on the applicable drawing or schematic diagram. All such drawing and diagrams shall be reviewed and signed by the appropriate circuit analyst prior to their initial release, and prior to subsequent issues following design revisions. Every effort should be made to design interchangeable modules or building blocks for various pieces of equipment to facilitate maintainability. Where electrical circuits, mechanical parts or assemblies are developed as interchangeable building blocks for equipment the analysis shall be conducted at the environments and stresses of the block in its most critical use. The data may then be applied for all building blocks in the design for the purpose of reliability estimation.

8.2 Failure Effect and Failure Mode Prediction Analysis Report. - A report shall be submitted to Grumman containing the complete details of the failure effect analysis. The report shall also include the results of any test which may have been performed to verify, in doubtful cases, the consequences of the assumed failure. Report updating shall consider all test failures and effect on performance.

8.2.1 Failure Effect Analysis. - An analysis of all conceivable failures and their effects on the mission capability of the system shall be conducted during the design phase to uncover critical reliability areas and direct appropriate engineering attention to them. In the early phases of design, the analysis shall consider the consequences of failures at higher levels of assembly. In the later design phases, the analysis shall become progressively more detailed and ultimately shall be conducted at the circuit level for electronic equipment and the piece part level (i.e. - valve, regulator, sensor, etc.) for non-electronic equipment. A complete failure-effect analysis shall be performed on each design and change to that design. A review of all failures during all tests shall be conducted monthly (if failures have occurred) and an evaluation of the effects of these failures, as compared to previously assumed effects, on equipment performance shall be made. The failure-effect analysis shall be revised if actual failure effects do not confirm assumed effects. The failure-effect analysis shall use the format shown as Table II and shall include the following:

(a) Block Diagram - Functional block and sequencing diagrams shall be used to define the operation of the subsystem and functional group of circuits or components. The design output requirements for each functional block shall be indicated.

(b) Item Number - This is the number assigned to each failure of each block in the block diagram for numerical identification.

(c) Assumed Failures - It shall be assumed that each functional block shall fail in turn. A systematic procedure shall be followed, where for each block, each output signal shall be assumed to fail in its most critical position or most adverse condition, both singly and in combination with other possible failures resulting in a critical condition. Any condition where the output does not meet the design output

8.2.1 (c) (Continued)

requirements shall be considered a failure. The systematic procedure shall assure that all conceivable failure modes, at the circuit level and higher, considering all anticipated environmental and operating stresses, shall be considered.

(d) Possible Cause - This is a brief description of the cause of each failure. Examples are: shorted components, plugged or leaky components, open circuited components, or structural failure. (Identify components or parts).

(e) Effects and Consequences - Effects and consequences of each failure on the next higher level of assembly and on the mission capability of the system.

(f) Method Detection - The method or means by which the failure would first become apparent.

(g) Compensating Provisions - Compensating provisions inherent in the design or alternate operating modes. This section shall include any corrective action, either automatic or required by an operator of the equipment, the results of that action, and an indication of the resulting degree of equipment degradation.

(h) Remarks - Any statement which would augment or clarify information of the preceding columns may be provided.

(i) Probability of Failure - A numerical value denoting the likelihood that the assumed failure could be experienced. Safety margins between strengths and stresses and derating factors at pertinent temperatures shall also be indicated, as appropriate. These factors shall be based on circuit and stress analyses which include determining applied environmental, mechanical, dynamic, and electrical loads, strength of materials, and load distribution.

(j) Failure Classification - Failure classifications separates the assumed failures into categories for the purpose of providing a comparative key to the gravity of the failure. Failures shall be classified as follows:

8.2.1 (j) (Continued)

CLASS I - Equipment or component inoperative or degraded to the point where it can no longer perform its intended function.

CLASS II - Same as Class I except that failure can be detected and corrective action taken by the crew while in flight. Corrective action may be by adjustment of equipment where such adjustments are provided, replacement of failed item where spares are provided, or by complete bypass of the failed item function by crew using other modes of operation. Failures falling in this category must be fully explained.

CLASS III - Equipment or component slightly degraded - will function and perform its intended purpose but possibly not within specified limits. These failures are not catastrophic in nature.

CLASS IV - Equipment or component not noticeably affected; nuisance type failures.

Combined consideration of the probability of occurrence with the gravity of the assumed failure will help establish engineering priority criteria for evaluating the failures in subsequent test activities, and for consideration of equipment redesign in critical areas.

8.2.2 Failure Mode Prediction Analysis. - An analysis indicating the anticipated modes of failure that would occur during the required stress-to-failure tests shall be conducted during the design phase in conjunction with the failure effect analysis. Each mode of failure shall be related to the environment(s) at which failure is anticipated. Where practical, the prediction analysis shall state the margin above the reliability boundary for the failure mode or modes predicted. The analysis need not consider environments above the stress-to-failure test levels.

9. QUALITY REPORTS AND DATA. - The following reports and data, as applicable, shall be prepared in accordance with Grumman Quality Control Procedures QCP 2.11, and/or NPC 200-2.

9.1 Acceptance Test Data Sheets. - Data sheets showing the results of acceptance tests performed by the Vendor shall be prepared. A copy of data sheets for all acceptance tests conducted on complete systems shall accompany the particular system whether the test is conducted at the Vendor or his subcontractor's plant.

9.2 Special Sampling Plan; Application of Sampling. - The Vendor shall provide special sampling plans; application of sampling, in accordance with the provisions of Paragraph 12.3 of NPC 200-2 as supplemented by QCP 2.11 or QCP 2.12.

9.3 Results of Special Measuring and Test Equipment Evaluation. - The Vendor shall provide results of special measuring and test equipment evaluation in accordance with the provisions of Paragraph 9.4 of NPC 200-2.

9.4 Monthly Quality Status Report. - The Vendor shall provide a monthly quality status report in accordance with the provisions of Paragraph 14.2 of NPC 200-2. This report shall be included as part of the requirement of Paragraph 13., Monthly Progress Report.

9.5 Quarterly Summaries of Quality Control Performance Audits. - The Vendor shall provide quarterly summaries of quality performance audits in accordance with the provisions of Paragraph 15.2 of NPC 200-2.

9.6 Test and Inspection Procedures. - The Vendor shall provide test and inspection procedures in accordance with the provisions of Paragraph 7.3.1 of NPC 200-2.

9.7 Process Control Procedures. - The Vendor shall provide process control procedures in accordance with provisions of Paragraph 7.5.4 of NPC 200-2.

9.8 End Item Test Plan and Test and Inspection Procedures. - The Vendor shall provide for qualification and deliverable hardware, an end item test plan in accordance with the provisions of Paragraph 7.4.2 of NPC 200-2 and end item test and inspection procedures in accordance with provisions of Paragraph 7.4.2.2 of NPC 200-2.

9.9 End Item Storage Procedures. - The Vendor shall provide storage procedures for end items in accordance with the provisions of Paragraph 11.5 of NPC 200-2.

9.10 End Item Narrative Report. - The Vendor shall prepare end item narrative report in accordance with the provisions of Paragraph 14.2.4 of NPC 200-2. Where any of these provisions are adequately covered by other documentation required by this VR, a copy shall be included as part of this report. End item narrative report shall be submitted to Grumman with each end item.

9.11 Material Review. - The Vendor shall provide, as required, material review documentation in accordance with the provisions of QCP 2.11.

9.12 Configuration Control Procedures. - The Vendor shall provide procedures for configuration control in accordance with the provisions of QCP 2.11. Procedures shall also include the Vendor system for identification and traceability in accordance with the provisions of Paragraph 4.4 and 5.7 of NPC 200-2.

10. SUPPORT MANUAL. -

10.1 Support Manual. - The Vendor shall furnish a support manual in accordance with the requirements listed below. Coverage shall include those categories defined in paragraphs 10.2.1.1 through 10.2.1.7 as applicable to the equipment under procurement.

10.2 Text. -

10.2.1 Text shall conform to high quality commercial standards, written for skilled technicians and engineering personnel, with a "text-in-support-of-illustration" approach where possible, and supplied as follows:

10.2.1.1 Description. - System(s) shall be described in sufficient detail to convey a clear understanding of the system as a whole.

10.2.1.2 Operating Procedures. - Detailed operating procedures presented in logical sequence shall be provided.

10.2.1.3 Emergency Procedures. - Emergency procedures, consisting of actions to be taken in the event of malfunction or interruption of the normal sequence of operations, shall be given. Safe shutdown procedures, backout, and methods of return to safe condition shall be included.

10.2.1.4 Checkout and Trouble Analysis. - Complete checkout and trouble analysis procedures to the module or assembly/sub-assembly level shall be in the form of step-by-step directions presented in a tabular format and in the normal sequence of operations.

10.2.1.5 Maintenance Instructions. - Maintenance instructions, limited to the replacement of failed modules or assembly/sub-assembly shall be given.

10.2.1.6 Handling and Servicing. - Special requirement for handling and servicing (cleaning, draining, lubrication, desiccant change, humidity and moisture checks, removal of covers, etc.) shall be given.

10.2.1.7 Adjustment, Alignment, and Calibration. - The procedural steps for adjustment, alignment, or calibration of equipment which must be performed periodically or after repair or replacement to assure correct performance shall be given in tabular form where possible.

10.3 Illustrations. -

10.3.1 Illustrations will be pencil sketches and engineering drawings as required in support of the text.

10.3.2 The pencil line art and engineering drawings submitted shall be of high reproducible quality with legible copy, and readable when reduced in size.

10.3.3 The symbols used on logic diagrams shall conform to MIL-STD-806B(DOD). Symbology not contained in MIL-STD-806(DOD) must have prior written approval by Grumman Publications.

10.3.4 Illustrations shall be supplied as oversize vellum reproducibles (preferably $1\frac{1}{2}$ times final size for $8\frac{1}{2}$ x 11 manuals) made from the original art. The original art shall be retained by the Vendor until requested by Grumman.

10.4 Copy Preparation. -

10.4.1 Copy is to be typewritten in elite type on $8\frac{1}{2}$ x 11 carbon-backed vellum, double-spaced, unjustified.

10.4.2 The United States Government Printing Office Style Manual shall be used as a guide for capitalization, punctuation, and compound word forms.

10.4.3 Abbreviations shall be held to a minimum. and shall be in accordance with Military Standard MIL-STD-12.

10.4.4 A standard system of test point identification by symbols based on Military Standard MIL-STD-16B, shall be incorporated in all pertinent tables and charts. MIL-STD-15 and MIL-STD-16B, shall be incorporated in all pertinent diagrams and illustrations. Symbology not contained in the above Military Specifications must have prior written approval by Grumman Publications.

10.5 Delivery. -

10.5.1 Preliminary text and illustrations as complete as possible, shall be delivered in accordance with subparagraph 1.2 of General Requirements, as called for in Table I.

10.5.2 Delivery of revised text and art, including new information as developed, shall be established by Grumman prior to Vendor's submittal of preliminary copy as called for above.

10.5.3 Changes to material submitted which affect safety of personnel, damage to equipment, or operability of equipment shall be effected by TWX to LEM Project, Attn: Publications Group.

10.5.4 Changes to material submitted which are needed to operate or maintain the equipment shall be mailed promptly to LEM Project, Attn: Publications Group.

10.6 Special Provisions. -

10.6.1 A thorough and formal validation program, documented by sign-off sheets, will be maintained. Preliminary information will be validated by using the procedures given in the written data to operate prototype hardware in the laboratories. In addition, design engineers will be required to review and certify the accuracy of the written materials. Verification sign-off sheets and engineering certification shall be delivered with the appropriate data.

10.6.2 A monthly Publications Progress Report shall be submitted with paragraph 13, Monthly Progress Report.

10.7 Maintainability Analysis. - The Vendor shall submit a report containing the results of the maintenance engineering analysis. All scheduled and unscheduled upkeep and rework tasks necessary to maintain the equipment at maximum readiness throughout its service life shall be identified. The report shall include a trouble detection and isolation analysis and classify all possible failures with regard to whether or not they must be repaired prior to the next phase of the mission. A final analysis will be submitted with the Support Manual.

10.7.1 Maintainability Analysis. - An analysis shall be conducted to determine which components will and which will not require maintenance during the life of the equipment, and every effort shall be made to design as many components as possible such that no maintenance will be required. Maintenance diagrams shall depict the physical location of the various parts, sub-assemblies, and units on the equipment, as well as show their schematic relationship to each other. This will allow maintenance personnel to readily associate the schematic diagram with the hardware. The diagrams shall be designed for ease of comprehension and use by technicians with a minimum of training and experience.

10.7.1 (Continued)

The diagrams shall be designed for ease of comprehension and use by technicians with a minimum of training and experience. The drawing format and size shall be suited for the task under anticipated environmental maintenance conditions. In addition, the diagram shall be designed to lead the maintenance technician through the necessary steps to test his equipment, to detect troubles, to isolate malfunctioning components, and to perform the repair action. Primary and secondary test points shall be uniquely marked. Waveforms, voltages, pressures, and other data expected at these points should be illustrated. The maintenance diagram shall tell the maintenance man where he should take measurements and what he should observe at the selected points. Equipment which requires periodic inspection, adjustments and other maintenance must be placed in the most accessible locations along with equipment having high failure rates. Whenever maintenance is necessary during the life of the equipment, the procedure for trouble detection, trouble isolation and repair shall be developed concurrently with the design, and the basic concepts shall be presented in the maintainability analysis. The analysis shall distinguish between maintenance during storage, test, on launch pad, and that which can be accomplished by the crew during the mission. Whenever feasible, trouble detection and isolation shall be automated compatible with economic considerations. A schedule for replacement of limited life items and Vendor recommendations for spares during the mission shall be included in the maintainability analysis. The product shall be designed for ease and safety of maintenance. Human Engineering and safety precautions shall be duly considered, and maintenance procedures which tend to cause people to make costly errors shall be avoided. Consideration shall be given to available skill levels of service personnel, to the configuration of the equipment as it appears to maintenance personnel in the field, and to the availability of spare parts, special tools, and facilities under operational conditions.

11. PHOTOGRAPHY. -

11.1 Engineering Photography. - The Vendor shall accomplish and submit engineering photography for the primary purpose of providing a permanent visual record to be used as raw data, similar to information obtained on telemetry-tape, oscillographs, etc. in the analysis and determination of specific test results. This coverage will include sequential, high-speed, and time lapse photography, in addition to any normal frame-rate coverage.

11.2 Documentary Photography. - The Vendor shall provide documentary photography in accordance with the following:

11.2.1 Objective. - The objective of documentary photography is to satisfy a Grumman need for documentation and reporting of Vendor research and development activities and progress. The still and motion picture coverage thus obtained will be used for purposes of LEM program evaluation and management analysis, written report backup, and the preparation of training, orientation, and briefing films. Other uses include legal, historical and the fulfillment of various information services requirements.

11.2.2 Standardization. - For purposes of compatibility and in the interest of economy in motion picture production, all phases of actual LEM filming by the Vendors shall be coordinated with the Motion Picture Section of Grumman.

11.2.2.1 Motion Picture Photography. - Motion picture photography shall be 16-mm. exposed at 24 frames per second. Any exception must be specifically authorized by Grumman. For normal motion picture photography, Eastman Ektachrome commercial type 7255, or equivalent, is recommended. When light conditions prevent the use of this film, Ektachrome ER type 7257 (daylight), or Ektachrome ER type 7258 (Tungsten), or equivalent, may be used. These high speed emulsions (ASA 160-120) should be used only when absolutely necessary, as some quality losses result in duplication. Black and white film and other frame-rates may be used in instances where the compatibility of the color film or the normal frame-rate would be detrimental to the accomplishment of specialized photographic coverage, such as aerial, engineering sequential, and time measurement photography.

11.2.2.2 Still Photography. - As a general rule, still photography shall be accomplished on 4 x 5 inch black and white film.

11.2.2.2 (Continued)

4 x 5 negative or reversible color film should be used in those instances where it is deemed essential to record and present the subject matter distinctly and accurately and for significant highlight events such as major tests, major delivery milestones, mockups, etc. The original camera raw stock film shall be of a type determined by the Vendor to be best suited to the recording objective under the prevailing environmental conditions of each photographic assignment.

11.2.3 Specifications. - Authenticity shall be adhered to in all photographic documentation required herein. Similar scenes from another activity, even though differences are minute, shall not be substituted for the activity being photographed. Activities shall not be staged or faked without specific requirements for this type of photography and any records or logs shall indicate the status of authenticity.

11.2.3.1 Motion Picture Specifications. -

11.2.3.1.1 Original film delivered under this purchase order shall not be projected prior to delivery to Grumman, and shall not be cut except to eliminate waste film caused by camera failure or faulty photographic techniques (gross over or under exposure, over or under development, out of focus, etc.) which result in qualitatively unsatisfactory film. Unusable heads and tails of scenes and unselected takes shall be destroyed by the Vendor.

11.2.3.1.2 All original camera film footage shall be slated whenever possible. Slate information shall include, as appropriate: Vendor identification, project number and/or name; purchase order number, security classification, date photographed, scene and take number. Three (3) copies of caption information describing the action involved in each scene and the significance of the sequences of which the individual scene is a part shall be forwarded with all original film footage delivered to Grumman. All individual reels of classified film footage shall bear head and tail security classification leaders.

11.2.3.2 Still Picture Specifications. -

11.2.3.2.1 The following data shall be lettered in ink on the clear margin of each original negative or color transparency on the acetate side starting from the left: negative number, date, Vendor, purchase order number, and classification.

11.2.3.2.1.1 The negative number: This shall be the Vendor's own numbering system for reference purposes.

11.2.3.2.1.2 The date shall consist of numerals for the data of the month, followed by the abbreviated name of the month, followed by the last two digits of the calendar year.

11.2.3.2.1.3 The Vendor's name shall be abbreviated and follow the date of the photograph.

11.2.3.2.1.4 The appropriate contract symbol beginning with the letters NAS shall follow the Vendor's name. The purchase order number, if applicable, shall also be included.

11.2.3.2.1.5 If the photograph is classified the classification shall follow the Vendor's name.

A typical negative marking would be as follows: 120/14 Jul 62/Grumman/NAS9-999/Vendor's name/P.O.382V2/Confidential.

11.2.3.2.2 Each negative or color equivalent shall be placed in a separate negative preserver. A contact print of the negative shall be attached to the front of the preserver (to insure minimum handling of the negative). The negative identification data shall be marked on the preserver starting in the top left front corner. In addition, the preserver shall be conspicuously marked with the proper classification in accordance with DOD Industrial Security Manual, Section II, Handling of Classified Information.

11.2.3.2.3 A written caption shall be prepared in three (3) copies for each negative produced which must include the who, what, when, where, and why type of data, as well as other pertinent facts including the specific date the photograph was taken. If nicknames are used, their meaning must be explained. The caption shall be typed double-spaced on a sheet of paper and may be placed either inside the negative preserver or attached to the back thereof.

11.2.3.2.4 The negative identification data specified above shall be reproduced on all prints made. This reproduction may be accomplished by any means available which will insure a permanent record of the identification data on each print, such as: photographic reproduction through the negative; by typing, waterproof ink lettering, ditto, or rubber stamp. In addition to the identification data, the front of each classified print shall be stamped with the appropriate classification (in the white border) at the top and bottom and on the back.

11.2.4 Requirements. - All photography specified herein shall be in a quantity sufficient to accomplish the objectives specified in Paragraph 11.2.1.

11.2.4.1 Motion Picture Requirements. - Vendor shall prepare written information describing the activities and items shown in the film footage required herein. Three (3) copies of such information shall accompany each shipment of film. Also, two (2) prints of all original film, matching frame for frame, shall be prepared to accompany delivery of all photographic requirements herein.

11.2.4.1.1 Routine Coverage. - Vendor shall accomplish on a continuing basis motion picture coverage of all significant highlight events as they occur. This coverage shall include the unsuccessful and unfavorable events as well as those representing positive activity and progress.

11.2.4.1.2 Film Clips. - The Vendor shall accomplish motion picture coverage as required for the preparation of film clips as directed by Grumman. Subject matter of this film footage will include coverage of special happenings such as mock-ups, test activities, and other events which depict the program progress and status. Footage suitable for use in the various Grumman film reports must portray a complete story of a specific research and development event, phase, or activity. The photographic coverage shall include a variety of scenes of the reported item of event, i.e., establishing shots, medium shots, close-ups, and cutaways, to assist the Grumman film editor in telling the story. The film footage shall consist of full length, unedited, untitled, silent scenes of sufficient length to provide a total of from five (5) to ten (10) minutes running time as received from the Vendor.

11.2.4.1.3 Special Film Requirements. - The production of briefing, concept, indoctrination films, and special animation sequences may be assigned to the Vendor from time to time by Grumman. The production of these special film reports will be subject to separate negotiation.

11.2.4.2 Still Photographic Requirements. - Vendor shall accomplish on a continuing basis still photographic documentation of all significant highlight events as they occur. This coverage shall include the unsuccessful and unfavorable events as well as those representing positive activity and progress. "Special Interest" highlight events shall be accomplished in color as specified in paragraph above. Routine documentation shall be done in black and white. A black and white contact print shall be prepared to accompany each black and white and color negative.

11.2.5 Guidelines. -

11.2.5.1 Scope of Coverage. - The following are typical types of photographic coverage which should be followed if applicable to this purchase order:

11.2.5.1.1 Conceptual artwork, mock-ups, models and all other display materials.

11.2.5.1.2 Meetings, conferences and symposiums of significant historical value.

11.2.5.1.3 Key personalities and operational personnel engaged in research, construction or test activities.

11.2.5.1.4 Field or in-house tests, checkouts and evaluations involved in research and development work on hardware, subsystems and systems.

11.2.5.1.5 Construction of facilities, laboratories, test equipment and operational machinery.

11.2.5.1.6 Training activities of MSC spacecraft pilots and all related support personnel.

11.2.5.1.7 Preparation for flight tests to include preparation of components and assembled systems for test.

11.2.5.1.8 All evaluation test programs conducted with program elements including life systems and flight systems.

11.2.5.1.9 All phases of launch operations including both booster and spacecraft activities.

11.2.5.1.10 If specifically directed by Grumman, support research and test work being conducted at other NASA installations and at any other Government organization.

11.2.5.2 Typical Photographic Outline. - A typical photographic outline is shown below. This example is a significant spacecraft test.

11.2.5.2.1 Views of the test environment identifying geographical location, equipment and personnel involved.

11.2.5.2.2 Cutaway views of signs, symbols and personnel manipulating equipment.

11.2.5.2.3 Views of key personalities actually engaged in activities of the particular exercise being photographed.

11.2.5.2.4 Views of the actual test activity in progress with emphasis on views that indicate success or failure of the activity.

11.2.5.2.5 Post-exercise views showing results. Personnel examining results and closeups of significant test items involved.

11.2.5.2.6 Closeups of faces, hands, dials and machines during activity.

11.2.5.2.7 Several views of general area where activity is going on before, during and after the activity.

12. VENDOR REPORTS AND DATA. -

12.1 Subcontracts. -

12.1.1 The Vendor shall submit copies of each subcontract or purchase order including Letter Contracts and Notices to Proceed and Work Statements in the following categories.

12.1.1.1 Those whose aggregate value exceeds $100,000 or is expected to exceed this amount. (Exclude those for raw materials and supplies and those primarily for supplementary engineering talent.)

12.1.1.2 Others which have important program significance.

12.1.2 The Vendor shall furnish to Grumman modifications such as Supplemental Agreements, Change Orders, Contract Change Notifications, and Administrative Notices to the documents specified above as they are issued.

12.1.3 The requirements of this Section 12.1 cover the submittal of documentation. Specific instructions with respect to procurement plans, advance notice and Grumman approval of purchase orders and second-tier subcontracts will be found in Section F, Terms and Conditions.

12.2 Vendor's Subcontractor Documentation. - The Vendor will spell out in its purchase orders that documentation which is required, i.e., schedules, reports, etc. Documents received from subcontractors will be added to the documentation list required by Paragraph 4.2.2.3 of this section and submitted to Grumman in the same manner as Vendor documentation is submitted to Grumman.

13. MONTHLY PROGRESS REPORT. - The Vendor shall submit a progress report of all work accomplished during each month of purchase order performance. This report shall be prepared as outlined below.

Summary of Program Highlights for the Month. -

Detailed report of progress by sections which will be permanently maintained each month of all items: (Discussion of problems and outline of next month's activities will be included in each section.)

(a) Design Data - Narrative description of all design activities as specified in Paragraph 5, Fuel Cell Assembly Design Data Report.

(b) Testing - Narrative description of test effort. Listing of all test summaries and results, and the test reports written by subject and number.

(c) Manufacturing - Narrative description of manufacturing effort with special emphasis on any fabrication difficulties being experienced on any component or assembly. Discussion on schedule status for engine hardware and tooling. List of tools completed and engine part number for which it is used. List of factory test equipment completed and part number with which it is used.

(d) Special Tooling/Special Test and Special Handling Equipment Report -

Special Tooling Report - After delivery of the first unit(s) of supplies called for in this purchase order, Vendor shall submit to Grumman a list of tools per Manufacturing Engineering Form 224 and completed as of the delivery of the first unit, detailing the quantity, the description, tool number and the individual cost (reasonably estimated if necessary) of each tool together with the part number for which it is used.

Quarterly Special Tooling Report - Vendor shall submit a similar list of tools which have been completed since the submission of the previous list. If there are no additional completed tools to report at the date of quarterly submission, a statement to that effect will be submitted. The completion invoice shall be accompanied by a list of any tools completed and not previously reported.

13. (d) (Continued)

Special Test and Special Handling Equipment Report - A list of "Lo-Value" special test and special handling equipment (items less than $5000) shall be submitted in accordance with Table I, using Grumman Form X21 (instructions to be furnished). "Hi-Value" equipment (items greater than $5000) shall be submitted in accordance with Table I, on Grumman Form X20. These forms shall be updated as more detailed information is available, but not less than quarterly. "Hi-Value" items shall be further described by sketches and/or photographs. The form will include provision for reporting completion status of special test and special handling equipment and shall accompany invoices for same.

(e) Test Facilities - Narrative description of progress on test facilities buildup and/or maintenance. Discussion of schedule status regarding activation of major facilities. Listing of major items of STE which have been installed.

(f) Reliability - Narrative description of reliability activities for the period. Included will be data meeting the requirements of the following paragraphs:

(1) Reliability Status Reports - A report of the status of the reliability effort shall be submitted to Grumman in accordance with Table I. The report shall include information derived from the following:

Reliability Apportionment - As a method of approach towards achieving the overall reliability requirement, the equipment reliability shall be apportioned among the various components on the basis of their relative complexity and relative importance to the successful operation of the equipment as indicated by the failure effect analysis. This initial apportionment shall be refined as the design progresses to reflect mission times, redundancy applications, multimodal concepts and other factors. The apportioned requirements shall be maintained up-to-date throughout the program in order to provide definitive design and test objectives for the hardware at all levels of assembly. All deviations from the initial apportionment shall be explained and noted in the Reliability Status Report.

13. (f) (1) (Continued)

Reliability Estimates - All phases of the design effort shall be monitored and up-to-date estimates of the reliability of all items of equipment and components shall be maintained. Reliability estimates shall be prepared in accordance with the procedures established in MIL-STD-756(WEPS). Reliability estimates for electronic equipment shall be based on the failure rates listed in MIL-HDBK-217, (or updated equivalent) except that other failure rates based on carefully selected parts may be used, subject to prior Grumman approval. Consideration for approval will be based on sufficient supporting data, such as justification of failure rates, environmental test results, availability, etc. All failure rates derived from sources other than MIL-HDBK-217 shall be listed in the same units and shall refer to the same performance and environmental conditions as the failure rates appearing in MIL-HDBK-217. All failure rates, regardless of their source, shall apply to parts which will be used in the delivered product. Reliability estimates for non-electrical equipment or components shall be based on failure rates subject to Grumman approval. The periodic status reports shall compare the reliability estimates with the apportioned reliability requirements, and point out anticipated or potential trouble areas. Estimates shall be presented in such a manner that the estimate for the overall equipment, or any of its components, subassemblies, or piece-parts may be readily identified. Estimates shall not be performed on a functional basis unless specifically requested by Grumman.

(2) Failure Reports - Failure reports shall be submitted for all failures occurring during qualification, acceptance, reliability, and developmental tests conducted by the Vendor. The reports shall be submitted in accordance with Table I.

Reporting Forms - Failure reports shall be made on forms to be supplied by Grumman or on an equivalent Vendor form approved by Grumman. As a minimum, the forms shall provide the following information, as applicable:

(a) Report Number.

(b) Reporting Activity (Name of Vendor or Supplier).

13. (f) (2) (Continued)

(c) System Type, Model Number.

(d) System Serial Number.

(e) Equipment Type, Model Designation; Model Number.

(f) Equipment Serial Number.

(g) Component or Major Assembly.

(1) Name
(2) Part Number
(3) Serial Number
(4) Manufacturer

(h) Subassembly or Module.

(1) Name
(2) Part Number
(3) Serial Number
(4) Manufacturer
(5) Part Reference Designator

(i) Failed Part/Item.

(1) Name
(2) Part Number
(3) Serial Number
(4) Manufacturer
(5) Reference Designator

(j) Date of Failure.

(k) Time on Failed Part/Item.

(1) Indicate time in hours and tenths.
(2) Indicate number of cycles or actuations if applicable.

(l) Name of test or other operation during which trouble was discovered.

(m) Description of trouble - include physical and functional condition of failed item or assembly.

(n) Failure Cause.

(o) Failure Classification.

13. (f) (2) (Continued)

(p) Disposition of Failed Subassembly/Module.

(q) Repair Action on Failed Subassembly/Module.

(1) Brief description of repair action. Indicate whether repair involves adjustment only, or whether replacement of parts is required.

(2) Condition of failed parts (repairable or scrap).

(3) Manufacturer's name, part number and serial number for each part replaced.

(4) Disposition of repaired item or assembly.

(5) Repair facility (where located).

(6) Repair time in hours and tenths.

(7) Man-hours to repair, hours and tenths.

Analysis of Failures - Submit as appendices to the Reliability Status Reports. Each analysis shall be completed subsequent to the date of failure, and the analysis report submitted in accordance with Table I. All failures reported shall be analyzed to determine the cause, failure classification, and corrective action required. Consideration shall be given to all applicable methods of failure diagnosis, including analysis studies, tests, x-ray, dissection, chemical analysis, etc. Results of the analysis of development test failures shall be submitted to Grumman as appendices to the reports. Analyses of failures occurring during qualification and acceptance tests shall be conducted immediately, and the results submitted to Grumman in accordance with Table I. The analysis results shall include, but shall not necessarily be limited to the following:

(a) Failure Report Number.

(b) Failure Cause.

(c) Effect of failure on major component, equipment, and subsystem, including any secondary failures

13. (f) (2) (c) (Continued)

caused by the initial, or primary failure. Revise as required failure-effect analysis Table II.

(d) Corrective action taken or contemplated, and effective date.

(e) Corrective action verification test plan.

(3) Reliability Data List - Submit in accordance with Table I. The list shall be updated and all changes and additions shall be submitted with the status report. As a minimum the Data List shall include all data indicated on Table III. It is not the intent of Grumman to dictate changes to the normal internal procedures of Vendors, however, the scope of the overall program and the number of different Vendors involved makes the use of some standardized forms essential for efficient control by Grumman. The upper section of Table III is the required configuration. The lower section configuration is at the option of the Vendor provided all information is included. The format shall be 11 x 17 inches in size. Additional data may be included at the option of the Vendor.

NOTE: Since the indicated column headings and codes may not be appropriate for all equipment, they may be changed as necessary at the option of the Vendor so long as the intent of the report is not altered. The following is an explanation of data required in each column of the list:

(a) Numerical designation of an item of the particular list.

(b) Reference designation. Schematic designation of the item - R, 101 C-121, etc.

(c) Description. All data necessary to describe the part or component such as title, value (ohms, capacitance, flow rate, pressure, etc. Any special data such as quad configuration or reference to other documents may be made in this column.

(d) Component or part number may be Vendor or military number.

13. (f) (3) (Continued)

(e) Procurement Specification. The applicable military or Vendor specification must be shown in this column.

(f) Insert the name of the manufacturer.

(g) Show total quantity of item used in this particular circuit or subassembly as applicable. (Diodes, valves, soldered or welded connections, etc.).

(h) Show duty cycle if applicable. The failure rate for many items such as relays, valves, and solenoids whose normal function is cyclic in nature, may be affected by the frequency of operation rather than time. Cycles may then be converted to failure rates based on total number of expected cycles.

(i) Application temperature is the maximum estimated, calculated or measured temperature in degrees centigrade. This should be updated as design and development progresses.

(j) Rates stress (volts, watts, current, pressure, pounds, etc.) is the maximum rating of the part at the application temperature. Show stress which is most critical to part failure.

(k) Application stress is the actual maximum applied stress in the particular circuit at the application temperature.

(l) Stress ratio is based on data in Column 10 and 11.

(m) Failure rate shall be indicated in failures 10^6 hours. Failure rate shall be preceded by a code letter keyed to failure rate source shown in the lower left hand block of the sheet. Code A and B shall be used for sources indicated. Other codes to be added by Vendor as applicable. Connections shall be included in addition to parts and components.

13. (f) (3) (Continued)

(n) Failure effects indicated are intended to aid in performing the Failure Effect Analysis. The code at each column heading is:

O - Open Type Failures

S - Short or Closed Type Failures

D - Degraded or Drift Type Failures

Failures shall be classified as follows and the applicable classification number inserted for each item under the failure mode indicated:

Class A - Equipment or circuit inoperative or degraded to the extent that it will no longer perform its intended function.

Class B - Equipment or circuit slightly degraded (the circuit will function but possibly not within required tolerance limits).

Class C - Nuisance type failure. No apparent degradation in performance.

(g) Materials Report - The Vendor shall furnish to Grumman, in summary form, those tests, experiments, developments, studies, and other efforts of the Vendor called for or required under this purchase order relating to materials and their processing for use in fulfilling the technical requirements of this purchase order. Include not only positive results, but also negative results which the Vendor considers significant to record, i.e., discarded efforts, unsuccessful tests, experiments, or developments.

(h) Training - Narrative report of training activities conducted for Grumman personnel. The report will cover progress made on course preparation and a description of classes conducted.

(i) Support Manual - Narrative report on the progress made on the preparation of the support manual.

(j) Maintainability Analysis - Narrative report on the results of the maintenance engineering analysis as specified in Paragraph 10.7.

13. (Continued)

(k) Vendor Activity - Narrative report which will describe major subcontracts, problems with Vendors and copies of pertinent Vendor correspondence.

(l) Other sections will be added at appropriate times, such as Qualification Status.

(m) Grumman Action Items - A short narrative description of items requiring action by Grumman.

14. FINANCIAL MANAGEMENT. -

14.1 PERT Requirements. - The Vendor will be required to use PERT (Program Evaluation and Review Technique) in a manner generally in conformance with that specified by the NASA PERT and Companion Cost System Handbook dated October 30, 1962 herein incorporated by reference. The Vendor shall prepare and maintain PERT networks as required to describe adequately the work he proposes to do. Networks shall show interface information between the Vendor and Grumman and any other organization or function. The updating is required every two (2) weeks. Network graphics are at the discretion of the Vendor. No particular computer program is mandatory although Grumman can supply a program if necessary, and any other technical assistance which may be necessary to implement a PERT capability if none presently exists in the Vendor's organization. The mechanics of the updating will be as mutually agreed upon between the Vendor and Grumman; this may be via IBM transceiver, TWX, mailed punchcards or tape, or keypunch input. Analysis reports will be required at Grumman within three working days of network update. Upon completion of the PERT networks, Grumman will be provided with lists which will show the correlation between PERT activities and the major components and sub-items as applicable.

14.2 Cost Reporting and Control Requirements. -

(a) A Form 533 Modified will be completed and forwarded by the fifth working day of each month starting with the second month of the program, until program completion.

The completed forms will be submitted in accordance with the Cost Package Instructions for the following:

(1) The total program.

(2) For each of the major items of the original proposal.

(b) Also required, a duplicate copy of accounting tabulation summaries of the actual incurred costs for each of the major components as originally proposed on the appropriate supporting Task Description/Direct Cost Form 533A.

(c) In the event that the projected costs of a major item is adjusted from the original submittal on Form 533 Modified, a completely revised set of supporting Task Description/ Direct Cost Estimate Form 533A are to be furnished for the major components, where applicable.

14.2 (Continued)

(d) The Vendor will be required to accumulate and control costs for the same levels as were submitted in the original proposal, by the major items (proposed on Form 533 Modified) and Task sub-items (proposed on supporting Task Description/Direct Cost Estimate Forms 533A). Said accountability and control should be maintained and be available for review at the discretion of Grumman.

(e) The Vendor shall forward notification of government audit approvals of revised direct labor, overhead, G and A, and other indirect rates and projection schedules, for the duration of the program.

14.3 Graphical Summary Report. - The Vendor shall submit quarterly a graphical actual cost/budgetary cost summary for the purchase order, including all commitments, and a graphical actual manpower/budgeted manpower summary for the purchase order (direct and indirect) for engineering, tooling, manufacturing quality, and test manhours. Actual data shall be used to the end of the reporting period and forecast data shall be used from that point in time to purchase order completion. These graphical reports shall be due at Grumman by the 10th calendar day of the month following the end of each quarter. These data shall be consistent with any related Form 533 Modified data.

APPENDIX

15. RELIABILITY ASSURANCE TEST ANALYSIS TECHNIQUE. - The analysis techniques described herein are based upon the assumption that the three parameter Weibull distribution is the underlying distribution of equipment failures. The choice of the Weibull distribution was made on the basis of the following:

15.1 Flexibility. - The Weibull distribution contains a shape parameter which makes the Weibull a family of distributions. Many of these distributions have been shown to be of value in describing equipment failure rate patterns (e.g., constant, wear out, wear-in). The Weibull is also capable of indicating changes in failure rate patterns of an equipment.

15.1.1 Economy. - A relatively small number of failures of an equipment type is necessary for analysis.

15.1.2 Simplicity. - Graphical techniques make the analysis easy to handle.

15.1.3 Theoretical. - The form of the Weibull cumulative distribution function coincides with the form of the cumulative distribution function of a general failure model (Ref. 1).

15.2 Procedures. -

15.2.1 A specific quantity of specimens is operated at the reliability boundary conditions for a period of time which is equivalent to the actual mission and then subjected to increasing stress levels until each specimen has failed. Before this test an upper bound to the stresses shall be established which represents the maximum practical stress level (Figure 2). This level shall be determined by giving consideration to controlling factors such as test equipment limitations, gross changes in equipment failure mode, material property changes, etc.

15.2.2 Each failure is noted and assigned a number indicating its position in the failure sequence (e.g., 1 = first failure occurring in sample, 2 = second failure occurring in sample, etc.).

15.2.3 Since the first specimen failure in a sample of specimens is an estimate of the percent of the population of equipments which would fail if the total population was tested, a rank must be assigned to each failure. The Median Rank, or rank whose probability of over-estimating (or underestimating) the percent of the total population that would fail at a given stress level is 0.5, is assigned to each failure. The Median Rank for each failure in a sample of ten is determined from the following table:

Failure Number	Median Rank(%)
1	6.7
2	16.3
3	25.9
4	35.6
5	45.2
6	54.8
7	64.4
8	74.1
9	83.7
10	93.3

Ref. Source: (2)

15.2.4 The Median Ranks are plotted on Weibull probability paper (% failed vs. % increase above reliability boundary levels.)

15.2.5 A straight line drawn in the direction of the array is made such that the array is split 50-50. This line is a best estimate of the failure distribution of the equipment type under test.

15.2.6 An upper 90% confidence point is plotted for each failure as follows:

(a) From the following table of 10% ranks (reference 3), for a sample of size ten determine the 10% rank for the first failure.

Failure Number	10% Ranks(%)
1	1.1
2	5.5
3	11.5
4	18.8
5	26.7
6	35.4
7	44.8
8	55.0
9	66.3
10	79.4

15.2.6 (Continued)

(b) Draw a horizontal line from the 10% rank value on the ordinate to the best estimate line ($\overline{AB}$ on Figure 1A).

(c) Draw a horizontal line from the Median Rank value of the first failure to the ordinate ($\overline{CD}$).

(d) Draw a vertical line through point B.

(e) The intersection of this vertical line and line ($\overline{CD}$) is the upper 90% confidence point for the first failure in ten (E) equipments. The following statement can now be made: There is a 90% probability that no more than 6.7% of the failure of this type equipment will occur at a stress level below S.

(f) The above procedure is utilized to determine the upper 90% confidence point for each of the remaining nine failures.

15.2.7 Connect the ten confidence points with a smooth curve to produce an upper 90% confidence band.

15.2.8 Extend the confidence curve until it intersects the % failure axis (1.001 x reliability boundary levels).

15.2.9 If the ordinate value of this point of intersection is greater than 5%, the testing has demonstrated that the equipment does not meet its reliability requirements. If the ordinate value of the point of intersection is less than or equal to 5%, the equipment is considered to have met its reliability requirements.

15.3 Sample Problem. - Ten equipment A's have successfully been taken through one mission simulation at the reliability boundary conditions of 0.08" D.A. sinusoidal vibration at a constant frequency of 100 c.p.s., and a temperature of 50°C. Upon completion of this simulation, the equipments were subjected to incremental increases in stress such that each increment represented a 10% increase in the severity of each environment (Figure 2). In the case of temperature, the 10% increments were based upon the equipment operating band of 0°C to +50°C. Failures were encountered at the following increments above the reliability boundary:

1.	10%	6.	60%
2.	20%	7.	70%
3.	30%	8.	70%
4.	40%	9.	80%
5.	50%	10.	90%

These percentage increases above the reliability boundary may be converted to inches D.A. and degrees F by the table below:

Increase above R.B.	D.A.	°C
100%	0.160	100
90%	0.152	95
80%	0.144	90
70%	0.136	85
60%	0.128	80
50%	0.120	75
40%	0.102	70
30%	0.104	65
20%	0.096	60
10%	0.088	55
Rel. Bound	0.080	50

e.g., 60% increase in stress above the reliability boundary is equal to a 0.128" D.A. sinusoidal vibration at 100 c.p.s. and a temperature of 80° C.

The Median Ranks for these failures are determined as in 15.2.3, and are plotted on Weibull probability paper (Figure 3). A straight line fit is made to the Median Rank points such that the array is split 50-50. The upper 90% confidence points are plotted as described in 15.2.6 and a smooth curve is drawn to connect these points. The curve is extended in the direction of the percent failed axis and intersects this axis at a percent failure value of approximately 2.75 percent. Therefore, the equipment is considered to have demonstrated compliance with the reliability requirements (no more than 5% failures below the reliability boundary at 90% confidence).

15.4 References. -

(1) A Summary of Some New Techniques on Failure Analysis. - John H. K. Kao, Proceedings of the Sixth National Symposium on Reliability and Quality Control, Pages 190-201, 1960.

(2) The Median Ranks of Sample Values in Their Population With An Application to Certain Fatigue Studies. - Leonard G. Johnson, Research Laboratories Division, General Motors Corporation, Detroit, Michigan.

(3) Pearson, E. S. and Hartley, H. O. (ed.) Biometrika Tables for Statisticians, Table 17, Volume I, Cambridge University Press, 1954.

TABLE I

DOCUMENTATION TYPE & DELIVERY SCHEDULE

Requirement Paragraph No.	Item	Initial Delivery (Months)*	Subsequent Issues or Revisions	Documentation Type	No. of Copies (Plus 1 Repro.)
3.	PROGRAM PLANS	1	As Requested	I	10*** 10****
4.	DRAWINGS & SPECIFICATIONS	12	As Released	I	3*** 3****
5.	FUEL CELL ASSEMBLY DESIGN DATA REPORT	2	Every Four Months Thereafter	I	3*** 3****
6.	DETAIL TEST PLAN	60 Days Prior to Test	As Released	I	3*** 3****
7.	TEST DATA AND REPORTS				
	SUMMARY	5 Days After Test	As Released	II	3
	FINAL	30 Days After Test	As Required	I	3*** 3****

* Initial delivery requirements are shown as time after purchase order go-ahead unless otherwise noted.

** These plans will only be updated upon written request by Grumman. On the average, revisions will be required about once every two months until they are initially acceptable and about once every six months thereafter.

*** Prior to Grumman approval.

**** Subsequent to Grumman approval.

TABLE I

DOCUMENTATION TYPE & DELIVERY SCHEDULE

Requirement Paragraph No.	Item	Initial Delivery (Months)*	Subsequent Issues or Revisions	Documentation Type	No. of Copies (Plus 1 Repro.)
8.	RELIABILITY REPORT				
	PRELIMINARY	2	As Required	I	3*** 3****
	FINAL	To Be Determined			
9.	QUALITY CONTROL OPERATING PROCEDURES	1 Month Prior to Use	As Required	I	3*** 3****
10.	SUPPORT MANUAL	16	As Required	I	1 Vellum
11.	PHOTOGRAPHY	As Required	As Required	II	To Be Established
12.	VENDOR REPORTS AND DATA				
12.1	Subcontracts	As Executed	As Executed	I	3*** 3****
12.1.2	Subcontract Change	As Released	As Released	II	3
12.2	Vendor's Subcontractor Documentation	2	As Released	II	1
13.	MONTHLY PROGRESS REPORT	10th Day of Month Following Receipt of Purchase Order	10th Day of Each Month	II	10
14.	FINANCIAL MANAGEMENT				

TABLE I

DOCUMENTATION TYPE & DELIVERY SCHEDULE

Requirement Paragraph No.	Item	Initial Delivery (Months)*	Subsequent Issues or Revisions	Documentation Type	No. of Copies (Plus 1 Repro.)
14.1	PERT Requirements	1 Mgmt	Every two Weeks	I Network	10*** 10****
		2 Detail	Every two Weeks	II Report	10
14.2	Cost Reporting and Control Requirements	10th Day of Month Following Receipt of Purchase Order	10th Day of each Month	II	10
14.3	Graphical Summary Report	10 Days After end of First Quarter	10 Days After end of each Quarter	II	10

* Initial delivery requirements are shown as time after purchase order go-ahead unless otherwise noted.

** These plans will only be updated upon written request by Grumman. On the average, revisions will be required about once every two months until they are initially acceptable and about once every six months thereafter.

*** Prior to Grumman approval.

**** Subsequent to Grumman approval.

Item	Measurement Name	Output	Class	Range	Frequency Response	Accuracy	Transducer Type	Signal Conditioning	Notes	Manufacture Model & Serial No.

INSTRUMENTATION MEASUREMENT LIST

FIGURE 1

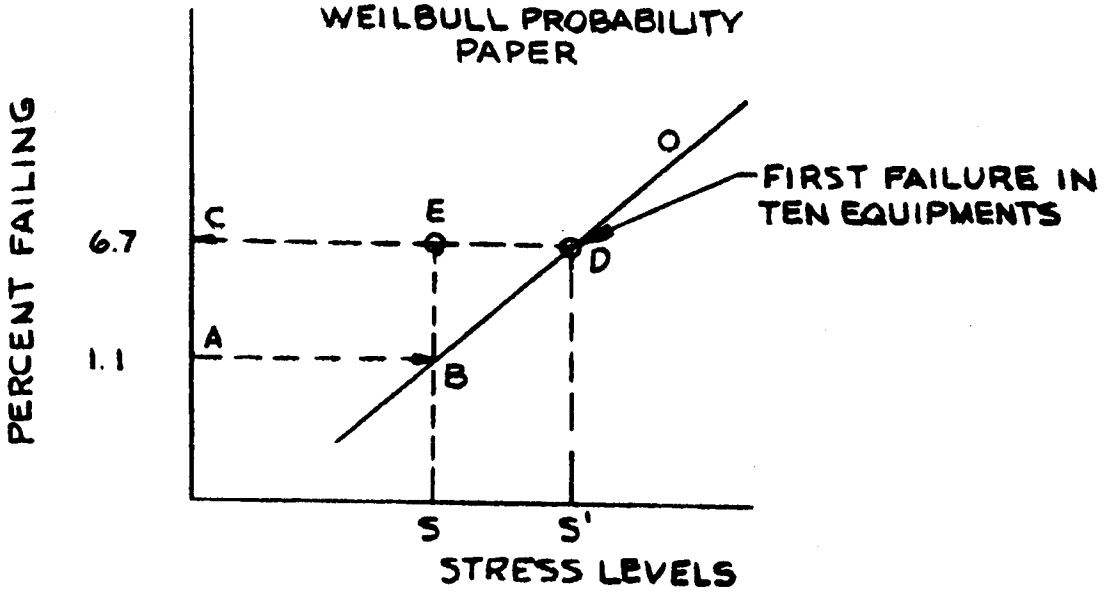


FIGURE 1A

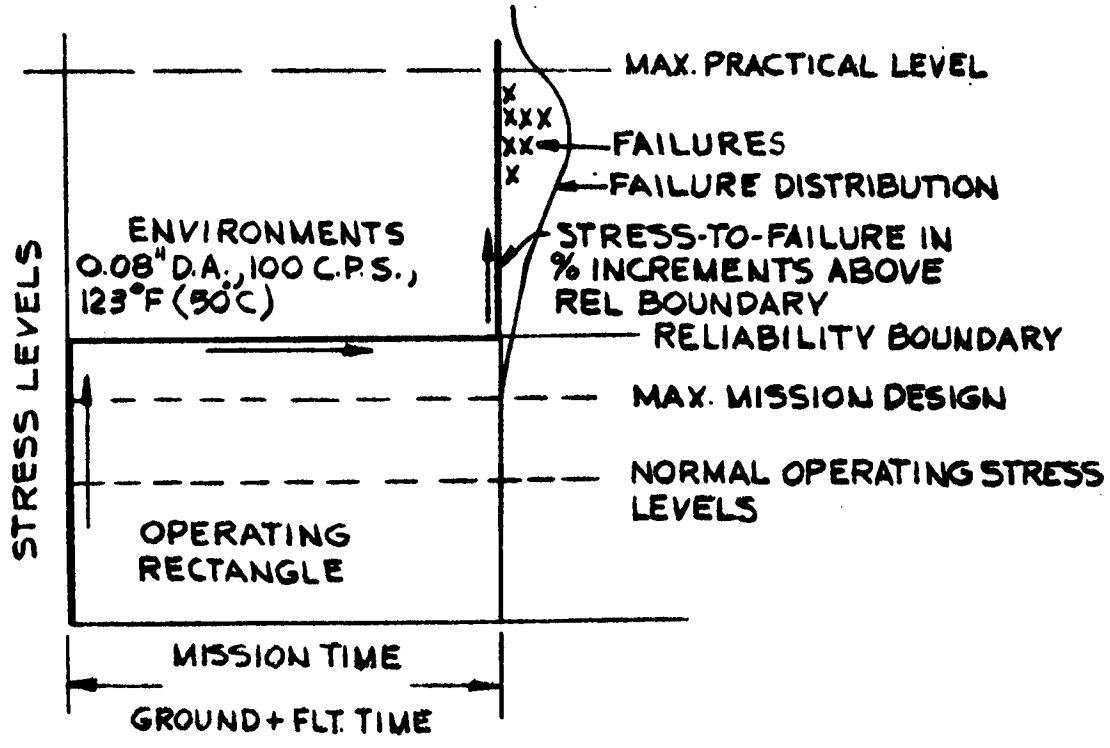
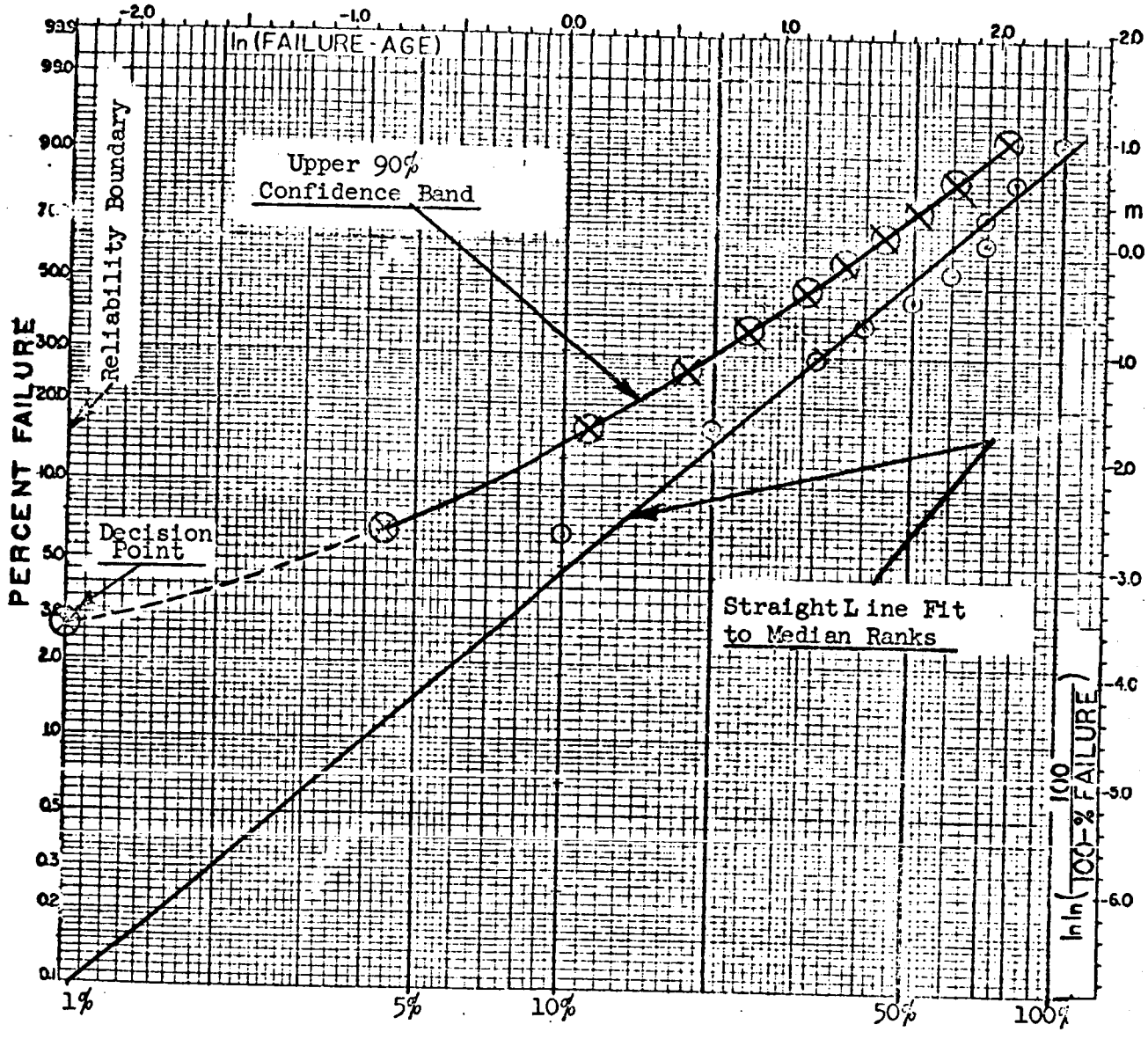


FIGURE 2

Weibull Probability Paper



Scale in % Above Reliability Boundary

FIGURE 3

EQUIPMENT: _____

PREPARED BY: _____

ISSUE DATE: _____

APPROVAL: _____

BLOCK DIAGRAM

(BLOCK DIAGRAM MAY BE IN THIS AREA OR ON SEPARATE SHEET THIS SIZE, AS APPROPRIATE) (TABLE SIZE 11 X 17")

ITEM NO	ASSUMED FAILURE	POSSIBLE CAUSE	EFFECTS AND CONSEQUENCES	METHOD OF DETECTION	INHERENT COMPENSATING PROVISIONS	REMARKS	PROB. OF FAILURE	FAILURE CLASS

TABLE II FAILURE EFFECT ANALYSIS

EQUIPMENT _____ IEM System and Subsystem Reliability Data List DATE _____

REFERENCE SCHEMATIC _____ PART NO. _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14		
ITEM NO.	REFERENCE DESIGNATION	DESCRIPTION	COMPONENT PART NUMBER	PROCUREMENT SPECIFICATION	MANUFACTURER	QTY. PER UNIT	DUTY CYCLE	APPL. TEMP. °C	RATED STRESS	APPL. STRESS	STRESS RATIO	FAILURE RATE	FAILURE EFFECT		
													O	S	D

FAILURE RATE SOURCES

A) MIL-HDBK-217

B) ESTIMATED

SIGNATURE AND DATE

PARTS AND COMPONENTS RELIABILITY DATA

Rev.

Sheet of

TABLE III

VENDOR REQUIREMENTS

FUEL CELL ASSEMBLY,

ELECTRICAL POWER SUBSYSTEM

FOR

LUNAR EXCURSION MODULE

LVR-390-2 29 April 1963

SECTION F - TERMS AND CONDITIONS

This section presents the legal clauses required by Grumman Procurement Policy as modified by the prime contract.

TABLE OF CONTENTS

ARTICLE 1 - DEFINITIONS

Unless the context otherwise requires, as used herein, the following terms shall have the meanings set forth below:

(a) The term "Government" means United States of America.

(b) The term "Administrator" means the Administrator or Deputy Administrator of the National Aeronautics and Space Administration; and the term "his duly authorized representative" means any person or persons or board (other than the Contracting Officer) authorized to act for the Administrator.

(c) The term "Contracting Officer" means the person who has executed the prime contract on behalf of the Government, and any other officer or civilian employee who is a properly designated Contracting Officer; and the term includes, except as otherwise provided in this purchase order, the authorized representative of the Contracting Officer acting within the limits of his authority.

(d) The term "prime contract" means the contract with the Government under which this purchase order has been issued.

(e) The term "NASA" means the National Aeronautics and Space Administration.

(f) The term "Grumman" means Grumman Aircraft Engineering Corporation.

(g) The term "Vendor" includes the term "Subcontractor" and means the individual, firm, or corporation to whom this purchase order is addressed and who is to furnish to Grumman the supplies and/or services procured under this purchase order.

(h) The term "subcontracts" includes purchase orders and orders.

(i) The term "purchase order" means the cost type purchase order of which these General Conditions (Cost Type) are a part.

ARTICLE 2 - LIMITATION OF COST

(a) It is estimated that the total cost go Grumman, exclusive of any fixed fee, for the performance of this purchase order will not exceed the estimated cost set forth in the Schedules, and Vendor agrees to use its best efforts to perform the work specified in the Schedule and all obligations under this purchase order within such estimated cost. If at any time Vendor has reason to believe that the costs which it expects to incur in the performance of this purchase order in the next succeeding 60 days, when added to all costs previously incurred, will exceed 75% of the estimated cost then set forth in the Schedule, or if at any time, Vendor has reason to believe that the total cost to Grumman, exclusive

ARTICLE 2 - (a) (Continued)

of any fixed fee, for the performance of this purchase order will be substantially greater or less than the then estimated cost thereof, Vendor shall notify Grumman in writing to that effect, giving its revised estimate of such total cost for the performance of this purchase order.

(b) Grumman shall not be obligated to reimburse Vendor for costs incurred in excess of the estimated cost set forth in the Schedule, and Vendor shall not be obligated to continued performance under the purchase order, or to incur costs in excess of the estimated cost set forth in the Schedule, unless and until Grumman shall have notified Vendor in writing that such estimated cost has been increased, and shall have specified in such notice a revised estimated cost which shall thereupon constitute the estimated cost of performance of this purchase order. When and to the extent that the estimated cost set forth in the Schedule has been increased, any cost incurred by Vendor in excess of such estimated cost prior to the increase in estimated cost shall be allowable to the same extent as if such cost had been incurred after such increase in estimated cost.

ARTICLE 3 - ALLOWABLE COST, FEE AND PAYMENT

Articles 3A and 3B are alternates. Article 3A applies in the event that this purchase order is issued on a cost plus a fixed fee basis, and Article 3B applies in the event that this purchase order is issued on a cost plus incentive fee basis.

ARTICLE 3A - ALLOWABLE COST, FIXED FEE AND PAYMENT

(a) For the performance of this purchase order, Grumman shall pay to Vendor:

(1) The cost thereof, both direct and indirect, (hereinafter referred to as "allowable cost") determined to be allowable in accordance with

(A) Part 2 of Section XV of the Armed Services Procurement Regulation (ASPR) as in effect on the date of this purchase order and which cost shall be that which is approved by Vendor's cognizant Government Audit Agency and accepted by cognizant Contracting Officer(s) as cost of Vendor in performing this purchase order; and

(B) The terms of this purchase order; and

(2) Such fixed fee, if any, as may be provided for in this purchase order.

ARTICLE 3A - (b) (Continued)

(b) Once each month (or at more frequent intervals, if approved by Grumman) Vendor may submit to Grumman in such form and reasonable detail as Grumman may require, an invoice supported by a statement of cost incurred by Vendor in the performance of this purchase order and claimed to constitute allowable cost. The invoice shall be certified by an authorized responsible official of Vendor.

(c) (1) As promptly as may be practicable after the receipt of each invoice and statement of cost Grumman shall, except as otherwise provided in this purchase order, and subject to the provisions of paragraph (d) below, make provisional payment thereon as approved by Grumman.

(2) Payment of the fixed fee, if any, shall be made at the time of each payment to Vendor on account of allowable cost. Vendor shall be paid an amount which is in the same ratio to the total fixed fee as the related payment being made on account of allowable cost is to the total estimated cost of performance of this purchase order; provided, however, that after payment of 85% of the fixed fee set forth in the Schedule, further payment on account of the fixed fee shall be withheld until a reserve of either 15% of the total fixed fee, or $100,000, whichever is less, shall have been set aside.

(d) At any time or times prior to final payment under this purchase order, Grumman or the Contracting Officer may have the invoices and statements of cost audited. Each payment theretofore made shall be subject to reduction for amounts included in the related invoices which are found by Grumman or the Contracting Officer, on the basis of such audit, not to constitute allowable cost. Any payment may be reduced for overpayments or increased for underpayments, on preceding invoices. Vendor shall accept as final the findings of the Contracting Officer with respect to all allowable cost, subject to the article of this purchase order entitled "Disputes; Right of Appeal."

(e) On receipt and approval of the invoice designated by Vendor as the "completion invoice," and upon compliance by Vendor with all the provisions of this purchase order (including, without limitation, the provisions relating to patents and the provisions of paragraph (f) below), Grumman shall promptly pay to Vendor any balance of allowable cost, and any part of the fixed fee, which has been withheld pursuant to paragraph (c) above, or otherwise not paid to Vendor. The completion invoice shall be submitted by Vendor promptly following completion of the work under this purchase order, but in no event later than one year (or such longer period as Grumman may in its discretion approve in writing) from the date of such completion.

ARTICLE 3A - (f) (Continued)

(f) Vendor agrees that any refunds, rebates, credits, or other amounts (including any interest thereon) accruing to or received by Vendor or any assignee under this purchase order shall be paid by Vendor to Grumman, to the extent that they are properly allocable to costs for which Vendor has been reimbursed by Grumman under this purchase order. Reasonable expenses incurred by Vendor for the purpose of securing such refunds, rebates, credits, or other amounts shall be allowable cost hereunder when approved by Grumman. Prior to final payment under this purchase order, Vendor shall execute and deliver:

(1) An assignment to Grumman, in form and substance satisfactory to Grumman, of refunds, rebates, credits, or other amounts (including any interest thereon) properly allocable to costs for which Vendor has been reimbursed by Grumman under this purchase order; and

(2) A release discharging Grumman, its officers, agents, and employees from all liabilities, obligations, and claims arising out of or under this purchase order subject only to the following exceptions -

(A) Specified claims in stated amounts or in estimated amounts where the amounts are not susceptible of exact statement by Vendor;

(B) Claims, together with reasonable expenses incidental thereto, based upon liabilities of Vendor to third parties arising out of the performance of this purchase order; provided, that such claims are not known to Vendor on the date of the execution of the release; and provided, further, that Vendor gives notice of such claims in writing to Grumman not more than 5 years after the date of the release or the date of any notice to Vendor that Grumman is prepared to make final payment, whichever is earlier;

(C) Claims for reimbursement of costs (other than expenses of Vendor by reason of its indemnification of Grumman against patent liability), including reasonable expenses incidental thereto, incurred by Vendor under the provisions of this purchase order relating to patents; and

(D) When there is included in this purchase order a clause entitled "Data Requirements," claims pursuant to such clause when a written request by Grumman to furnish data is made within the one year period after final payment.

ARTICLE 3A - (g) (Continued)

(g) Any cost incurred by Vendor under the terms of this purchase order which would constitute allowable cost under the provisions of this article shall be included in determining the amount payable under this purchase order, notwithstanding any provisions contained in the specifications or other documents incorporated in this purchase order by reference, designating services to be performed or materials to be furnished by Vendor at its expense or without cost to Grumman.

(h) Payment for overtime and shift premiums shall be made only to the extent provided by NASA PR 12.102-3 (h)(1) which is incorporated herein and made a part hereof. In order to make the context of this clause applicable to this purchase order, the term "Government" shall mean "Grumman" and the term "contract" shall mean this purchase order.

ARTICLE 3B - ALLOWABLE COST, INCENTIVE FEE, AND PAYMENT

(a) (1) For the performance of this purchase order, Grumman shall pay to the Vendor:

(A) The cost thereof, both direct and indirect, (hereinafter referred to as "allowable cost") determined to be allowable in accordance with -

(i) Part 2 of Section XV of the Armed Services Procurement Regulation (ASPR) as in effect on the date of this purchase order, and which cost shall be that which is approved by Vendor's cognizant Contracting Officer(s) as cost of Vendor in performing this purchase order; and

(ii) The terms of this purchase order; and

(B) A fee determined as provided in this purchase order.

(2) The target cost, target fee, target weight and target delivery date of this purchase are set forth in the Schedule and shall be subject to adjustment in accordance with paragraphs (h) and (i) below.

(3) As used throughout this purchase order the term:

(A) "Target cost" means the estimated cost of this purchase order initially negotiated, adjusted in accordance with paragraph (h) below;

ARTICLE 3B - (a) (Continued)

(B) "Target fee" means the fee which was initially negotiated on the assumption that this purchase order would be performed for a cost equal to the estimated cost of this purchase order and at the weight and on the delivery date initially negotiated, adjusted in accordance with paragraph (h) below;

(C) "Target weight" means the target weight set forth elsewhere in this purchase order, adjusted in accordance with paragraph (h) below.

(b) Once each month (or at more frequent intervals, if approved by Grumman) Vendor may submit to Grumman, in such form and reasonable detail as Grumman may require an invoice supported by a statement of cost incurred by Vendor in the performance of this purchase order and claimed to constitute allowable cost. The statement of cost shall be certified by an authorized responsible official of Vendor.

(c) (1) As promptly as may be practicable after the receipt of such invoice and statement of cost, Grumman shall, except as otherwise provided in this purchase order, and subject to the provisions of paragraph (d) below, make provisional payment thereon as approved by Grumman.

(2) Payment of fee shall be made at the time of each payment to vendor on account of allowable cost. Vendor shall be paid an amount which is in the same ratio to the total target fee as the related payment being made on account of allowable cost is to the total target cost of this purchase order; provided, however, that after payment of eighty-five percent (85%) of the minimum fee provided for in paragraph (i) below, further payment on account of the fee shall be withheld until a reserve of either fifteen percent (15%) of the target fee, or two hundred thousand dollars ($200,000), whichever is less, shall have been set aside.

(d) At any time or times prior to final payment under this purchase order, Grumman or the Contracting Officer may have the invoices and statements of cost audited. Each payment theretofore made shall be subject to reduction for amounts included in the related invoice which are found by Grumman or the Contracting Officer, on the basis of such audit, not to constitute allowable cost. Any payment may be reduced for overpayments or increased for underpayments, on preceding invoices. Vendor shall accept as final the findings of the Contracting Officer with respect to all allowable cost, subject to the article of this purchase order entitled "Disputes; Right of Appeal."

(e) On receipt and approval of the invoice designated by Vendor as the "completion invoice," and upon compliance by Vendor with all the provisions of this purchase order (including, without limitation,

ARTICLE 3B - (e) (Continued)

the provisions relating to patents and the provisions of paragraph (f) below), Grumman shall promptly pay to Vendor any balance of allowable cost, and any part of the fee, which has been withheld pursuant to (c) above or otherwise not paid to Vendor. The completion invoice shall be submitted by Vendor promptly following completion of the work under this purchase order but in no event later than one (1) year (or such longer period as Grumman may in its discretion approve in writing) from the date of such completion.

(f) Vendor agrees that any refunds, rebates, credits, or other amounts (including any interest thereon) accruing to or received by Vendor or any assignee under this purchase order shall be paid by Vendor to Grumman to the extent that they are properly allocable to costs for which Vendor has been reimbursed by Grumman under this purchase order. Reasonable expenses incurred by Vendor for the purpose of securing such refunds, rebates, credits, or other amounts shall be allowable costs hereunder when approved by Grumman. Prior to final payment under this purchase order, Vendor, and each assignee under this purchase order whose assignment is in effect at the time of final payment under this purchase order, shall execute and deliver:

(1) An assignment to Grumman, in form and substance satisfactory to Grumman, of refunds, rebates, credits, or other amounts, (including any interest thereon) properly allocable to costs for which Vendor has been reimbursed by Grumman under this purchase order; and

(2) A release discharging Grumman, its officers, agents, and employees from all liabilities, obligations, and claims arising out of or under this purchase order, subject only to the following exceptions--

(A) Specified claims in stated amounts or in estimated amounts where the amounts are not susceptible of exact statement by Vendor;

(B) Claims, together with reasonable expenses incidental thereto, based upon liabilities of Vendor to third parties arising out of the performance of this purchase order; provided that such claims are not known to Vendor on the date of the execution of the release; and provided further that Vendor gives notice of such claims in writing to Grumman not more than five (5) years after the date of the release or the date of any notice to Vendor that Grumman is prepared to make final payment, whichever is earlier;

(C) Claims for reimbursement of costs (other than expenses of Vendor by reason of its indemnification of Grumman against patent liability), including reasonable expenses incidental

ARTICLE 3B - (f) (Continued)

(C) thereto, incurred by the Vendor under the provisions of this purchase order relating to patents; and

(D) When there is included in this purchase order a clause entitled "Data Requirements," claims pursuant to such clause when a written request by Grumman to furnish data is made within the one year period after final payment to Grumman under the prime contract.

Payments under the assignment and the claims excepted from the release shall be subject to adjustment by reason of the adjustment of fee in accordance with paragraph (i) below.

(g) Any cost incurred by Vendor under the terms of this purchase order which would constitute allowable cost under the provisions of this clause shall be included determining the amount payable under this purchase order, notwithstanding any provisions contained in the specification or other documents incorporated in this purchase order by reference, designating services to be performed or materials to be furnished by Vendor at its expense or without cost to Grumman.

(h) When the work under this purchase order (including any supplies or services which are ordered separately under, or otherwise added to, this purchase order) is increased or decreased by purchase order modification, appropriate adjustments in the target cost, target fee, target weight and target delivery date shall be set forth in an amendment to this purchase order.

(i) The fee payable hereunder shall be the target fee increased by *(A) cents for every dollar by which the total allowable cost is less than the target cost or decreased by *(B) cents for every dollar by which the total allowable cost exceeds the target cost, increased by *(C) dollars for every pound by which the total weight is less than the target weight or decreased by *(D) dollars for every pound by which the total weight exceeds the target weight, and increased by *(E) dollars for every day that delivery precedes the target delivery date or decreased by *(F) dollars for every day that delivery is after the target delivery date. In no event shall the fee be greater than *(G)%, nor less than *(H)%, of the target cost; and within these limits such fee shall be subject to adjustment by reason of increase or decrease of total allowable cost, on account of payments under the assignment required by paragraph (f) (1) above, and claims excepted from the release required by paragraph (f) (2) above.

ARTICLE 3B - (j) (Continued)

(j) Any reference in this purchase order to the article entitled "Allowable Cost, Fixed Fee and Payment" shall be interpreted as a reference to this article, any reference in this purchase order to the term "estimated cost" shall be interpreted as a reference to "target cost" and any reference in this purchase order to the term "fixed fee" shall be interpreted as a reference to "target fee."

(k) Payment for overtime and shift premiums shall be made only to the extent provided by NASA PR 12.102-3 (h)(1) which is incorporated herein and made a part hereof. In order to make the context of this clause applicable to this purchase order, the term "Government" shall mean "Grumman" and the term "contract" shall mean this purchase order.

* See Schedule

ARTICLE 4 - CHANGES

(a) Grumman may at any time, by a written order, signed by Grumman's Manager of Procurement, and without notice to the sureties, if any, make changes, within the general scope of this purchase order, in any one or more of the following:

(1) Drawings, designs, or specifications, where the supplies to be furnished are to be specially manufactured for Grumman in accordance therewith;

(2) Method of shipment or packing;

(3) Place of inspection, delivery or acceptance;

(4) Amount of Grumman and/or Government Furnished Property;

(5) Quantity of supplies; and

(6) Delivery schedule.

(b) If any such change causes an increase or decrease in the estimated cost of, or the time required for, the performance of any part of the work under this purchase order, whether changed or not changed by any such written order, or otherwise affects any other provision of this purchase order, an equitable adjustment shall be made:

(1) In the estimated cost or delivery schedule, or both;

(2) In the amount of any fixed fee to be paid to the Vendor; and

(3) In such other provisions of this purchase order as may be so affected, and this purchase order shall be modified in writing accordingly.

ARTICLE 4 - (c) (Continued)

(c) Any claim by Vendor for adjustment under this article must be asserted within 30 days from the date of receipt by Vendor of the notification of change; provided, however, that Grumman, if it decides that the facts justify such action, may receive and act upon any such claim asserted at any time prior to final payment under this purchase order. However, nothing in this article shall excuse Vendor from proceeding with this purchase order as changed.

(d) Notwithstanding the provision of paragraph (b) above, no increase in the fixed fee shall be made due to any change of the type contemplated by subparagraph (1) of paragraph (a) above unless such change affects the estimated cost by more than that portion of the estimated cost set forth in the Schedule hereof.

ARTICLE 5 - STANDARDS OF WORK

The Vendor agrees that the performance of work and services pursuant to the requirements of this purchase order shall conform to high professional standards.

ARTICLE 6 - INSPECTION, CORRECTION OF DEFECTS

(a) All work under this purchase order shall be subject to inspection and test by Grumman and the Government (to the extent practicable) at all times (including the period of performance) and places, and in any event prior to acceptance. Vendor shall provide maintain an inspection system acceptable to Grumman and Government, covering the work hereunder. Grumman and/or the Government, through any of its authorized representatives, may inspect the plant or plants of the Vendor or of any of its subcontractors engaged in the performance of this purchase order. If any inspection or test is made by Grumman and/or the Government on the premises of the Vendor or any of its subcontractors, Vendor shall provide and shall require his subcontractors to provide all reasonable facilities and assistance for the safety and convenience of the Grumman and/or Government inspectors in the performance of their duties. All inspections and tests by Grumman and/or the Government shall be performed in such a manner as will not unduly delay the work. In the performance of the work required herein, Vendor agrees to give access to and cooperate with other subcontractors under the prime contract and other prime contractors to be designated by NASA Manned Spacecraft Center (hereinafter referred to as NASA/MSC) which other prime contractors shall assist NASA/MSC in the technical monitoring of progress required and in the systems coordination which is necessary for the accomplishment of responsibilities to be assigned to these other prime contractors. It is expressly understood that such other prime contractors shall not be empowered to effect any changes or issue any directions to Vendor for the work required by this purchase order. Such change and/or directions shall be made in accordance with the clause of this purchase order as may be appropriate.

ARTICLE 6 - (b) (Continued)

(b) If supplies are ready for delivery hereunder prior to completion of the qualification tests required by this purchase order or by any prior purchase order with Vendor for supplies of the type to be delivered hereunder, Grumman may nevertheless provisionally accept such supplies upon (i) satisfactory completion by Vendor of the acceptance tests for the supplies concerned; (ii) tender by Vendor of the supplies, completed and ready for shipment; and (iii) final inspection of the supplies by Grumman. In the event that supplies have been provisionally accepted hereunder, Vendor shall, as a condition precedent to final acceptance, be obligated to complete such qualification tests successfully and to incorporate in all such supplies, (i) corrections of a type required to pass qualification tests; and (ii) replacements for non-approved, non-standard parts. At any time during performance of this purchase order, but not later than seven months after final acceptance by the Government under the prime contract of all the end items (other than designs, drawings or reports) delivered by Grumman incorporating the supplied or lots of supplies under this purchase order, Grumman may require Vendor to remedy by correction or replacement, as directed by Grumman, any failure by Vendor to comply with the requirements of this purchase order. Any time devoted to such correction or replacement shall not be included in the computation of the period of time specified in the preceding sentence, except as provided in paragraph (d) below. Except as otherwise provided in paragraph (c) below, the cost of any such replacement or correction shall be included in allowable cost determined as provided in the article of this purchase order entitled "Allowable Cost, Fixed Fee and Payment," but no additional fee shall be payable with respect thereto. Corrected articles shall not be tendered thereafter for acceptance unless the former tender and the requirement of correction is disclosed. If Vendor fails to proceed with reasonable promptness to perform such correction, Grumman:

(1) May by contract or otherwise perform such replacement or correction and charge to Vendor any increased cost occasioned Grumman thereby, or may reduce any fixed fee payable under this purchase order (or require repayment of any fixed fee theretofore paid) in such amount as may be equitable under the circumstances, or

(2) In the case of articles not delivered, may require the delivery of such articles, and shall have the right to reduce any fixed fee payable under this purchase order (or to require repayment of any fixed fee theretofore paid) in such amount as may be equitable under the circumstances, or,

(3) May terminate this purchase order for default as provided in the article of this purchase order entitled "Termination."

ARTICLE 6 - (c) (Continued)

(c) Notwithstanding the provisions of paragraph (b) above, Grumman may at any time require the correction or replacement by Vendor, without cost to Grumman, any failure by Vendor to comply with the requirements of this purchase order, if such failure is due to fraud, lack of good faith or willful misconduct on the part of any of the Vendor's directors or officers, or on the part of any of its managers, superintendents or other equivalent representatives, who has supervision or direction of (i) all or substantially all of Vendor's business, or (ii) all or substantially all of Vendor's operations at any one plant or separate location in which this purchase order is being performed or (iii) a separate and complete major industrial operation in connection with the performance of this purchase order. Grumman may at any time also require correction or replacement by Vendor, without cost to Grumman, any such failure caused by one or more individual employees selected or retained by Vendor after any such supervisory personnel has reasonable grounds to believe that any such employee is habitually careless or otherwise unqualified.

(d) Corrected supplies or replaced supplies shall be subject to this article in the same manner and to the same extent as supplies originally delivered under this purchase order.

(e) Vendor shall make its records of all inspection work available to Grumman and/or the Government during the performance of this purchase order and for such longer period as may be specified in this purchase order.

(f) Except as provided in this article and as may be provided in the Schedule, Vendor shall have no obligation or liability to correct or replace supplies or lots of supplies which at the time of delivery are defective in material or workmanship or otherwise not in conformity with the requirements of this purchase order.

(g) Except as otherwise provided in the Schedule, Vendor's obligation to correct or replace Grumman-Furnished Property and/or Government-Furnished Property (which is property in the possession of or acquired by Grumman and/or the Government and delivered or otherwise made available to Vendor) shall be governed by the article of this purchase order entitled "Grumman and/or Government Property."

(h) If Grumman has design control over the supplies to be furnished hereunder, Vendor's system of qualify control shall comply with Grumman Quality Control Procedure, Q.C.P. 2.11 or 2.12, as specified in the in the Schedule, as in effect on the date of this purchase order and such Quality Control Procedure is incorporated herein by reference and made a part hereof.

ARTICLE 7 - TERMINATION

(a) Grumman may, at any time, by written order signed by Grumman's Manager of Procurement, terminate this purchase order in whole or in part.

(1) Whenever Vendor is in default in the performance of this purchase order in accordance with its terms (including in the term "default" any such failure by Vendor to make progress in the prosecution of the work hereunder as endangers such performance), and shall fail to cure such default within a period of 10 days (or such longer periods as Grumman may allow) after receipt from Grumman of a notice specifying the default; or

(2) Whenever for any reason Grumman shall determine that such termination is in the best interests of Grumman and/or the Government.

Any such termination shall be effected by delivery to Vendor of a notice of termination specifying whether termination is for the default of Vendor or for the convenience of Grumman and/or the Government, the extent to which performance of work under the purchase order is terminated, and the date upon which such termination becomes effective. If, after notice of termination of this purchase order for default under (1) above, it is determined that Vendor's failure to perform or to make progress in performance is due to causes beyond the control and without the fault of negligence of Vendor pursuant to the article of this purchase order entitled "Excusable Delays," the notice of termination shall be deemed to have been issued under (2) above and the rights and obligations of the parties hereto shall in such event be governed accordingly.

(b) If this purchase order is terminated, settlement shall be made in accordance with the principles and provisions of NASA Procurement Regulations 8.702 (hereinafter referred to PR) as in effect on the date of this purchase order except that subparagraph (f) of said NASA PR 8.702 shall not be applicable to this purchase order and except that wherever the term "one (1) year" appears in subparagraph (c) of said NASA PR 8.702 it shall be deleted and "six (6) months" inserted in lieu thereof. In applying said principles and provisions of NASA PR 8.702 the terms "Government" and "Contracting Officer" shall be deemed to refer to Grumman and the term "Contractor" shall be deemed to refer to Vendor; provided, however, that nothing contained in this paragraph (b) shall modify any requirement of NASA PR 8.702 that title shall be transferred to the Government.

ARTICLE 8 - EXCUSABLE DELAYS

Vendor shall not be in default by reason of any failure in performance of this purchase order in accordance with its terms, or any failure by Vendor to make progress in the prosecution of the work hereunder which endangers such performance, if such failure arises out of causes beyond the control and without the fault or negligence of Vendor; provided, however, that Vendor has notified Grumman in writing of the cause of such failure within 10 days from the beginning thereof.

ARTICLE 9 - DISPUTES, RIGHT OF APPEAL

(a) Notwithstanding any provisions herein to the contrary, if Vendor disagrees with any determination of the Contracting Officer with respect to allowable costs hereunder, Vendor shall promptly notify Grumman thereof and the specific reasons thereof and shall furnish any relevant information and documentation. On receipt of such notification, Grumman shall promptly negotiate with Vendor to resolve such disagreement. If Grumman and Vendor agree to accept such determination by the Contracting Officer, the Vendor shall promptly so advise Grumman in writing. In the event that Grumman and the Vendor are unable to resolve such disagreement, then Grumman agrees to negotiate with the Contracting Officer do not reach an agreement satisfactory to the Vendor then, in that event Grumman agrees to appeal such decision in accordance with the clause of the prime contract entitled "Disputes." Grumman further agrees promptly to furnish Vendor with a copy of such appeal and to permit Vendor to participate fully under Grumman direction in all phases of the appeal which affect the Vendor's interest, including preparation of pleadings, introduction of evidence and presentation of arguments and briefs. Any decision upon a matter in dispute under this purchase order if binding upon Grumman, shall also be binding upon Vendor. In no event shall any of the foregoing be deemed to authorize Vendor a direct appeal to the Administrator concerned or his duly authorized representative nor shall it be deemed to authorize Grumman and/or the Vendor to prosecute an appeal not arising under the prime contract under which this purchase order is issued.

(b) Any dispute arising under this purchase order which is not settled by agreement of the parties or pursuant to paragraph (a) above may be settled by appropriate legal proceedings.

(c) All costs of any proceedings as hereinabove provided for shall be paid by Vendor without prejudice to any right Vendor may otherwise have to the recovery or allowance thereof. Pending any decision, appeal or judgment referred to in this clause or the settlement of any dispute arising under this purchase order, Vendor shall proceed diligently with the performance of this purchase order.

ARTICLE 10 - GRUMMAN AND/OR GOVERNMENT PROPERTY

(a) Grumman shall deliver to Vendor, for use in connection with and under the terms of this purchase order, the property described in the VR or Specifications, together with such related data and information as Vendor may request and as may reasonably be required for the intended use of property. Any such property shall be hereinafter referred to as "Grumman or Government Furnished Property," and property solely belonging to Grumman may hereinafter be referred to as "Grumman-Furnished Property," and any such property solely belonging to the Government hereinafter may be referred to as "Government-Furnished Property." The delivery or performance dates for the supplies or services to be

ARTICLE 10 - (a) (Continued)

furnished by Vendor under this purchase order are based upon the expectation that Grumman or Government Furnished Property suitable for use will be delivered to Vendor at the times stated in the delivery schedule or, if not so stated, in sufficient time to enable Vendor to meet such delivery or performance dates. In the event that Grumman or Government Furnished Property is not delivered to Vendor by such time or times, Grumman shall, upon timely written request made by Vendor, make a determination of the delay occasioned Vendor and shall equitably adjust the estimated cost, fixed fee, or delivery or performance dates, or all of them, and any other contractural provisions affected by such delay, in accordance with the procedures provided for in the article of this purchase order entitled "Changes." In the event that Grumman or Government Furnished Property is received by Vendor in a condition not suitable for the intended use, Vendor shall, upon receipt thereof notify Grumman of such fact and, as directed by Grumman, either (i) return such property at Grumman's expense or otherwise dispose of the property, or (ii) effect repairs of modification. Upon completion of (i) or (ii) above, Grumman, upon written request of Vendor shall equitably adjust the estimated cost, fixed fee, or delivery of performance dates, or all of them, and any other provision of this purchase order affected by the return or disposition, or the repair or modification, in accordance with the procedures provided for in the article of this purchase order entitled "Changes." The foregoing provisions for adjustment are exclusive and Grumman shall not be liable to suit for breach of contract by reason of any delay in delivery of Grumman or Government Furnished Property or delivery of such property in a condition not suitable for its intended use.

(b) Title to all Grumman-Furnished Property shall remain in Grumman. Title to all Government-Furnished Property shall remain in the Government. Title to all property purchased by Vendor for the cost of which Vendor is entitled to be reimbursed as a direct item of cost under this purchase order shall pass to and vest in the Government upon delivery of such property to Vendor. Title to other property, the cost of which is reimbursable to Vendor under this purchase order, shall pass to and vest in the Government upon (i) issuance for use of such property in the performance of this purchase order, or (ii) commencement of processing or use of such property in the performance of this purchase order, or (iii) reimbursement of the cost thereof by Grumman, in whole or in the percentage prevailing by reason of the article of this purchase order entitled "Allowable Cost, Fixed Fee and Payment," whichever occurs first. All Government-Furnished Property together with all property acquired by Vendor, title to which vests in the Government under this paragraph, are subject to the provisions of this article and are hereinafter collectively referred to as "Government Property."

ARTICLE 10 - (c) (Continued)

(c) Title to the Grumman-Furnished Property and/or Government Property shall not be affected by the incorporation or attachment thereof to any property not owned by Grumman or the Government, nor shall such Grumman-Furnished Property, or any part thereof, be or become a fixture or lose its identity as personalty by reason of affixation to any realty. Vendor shall comply with the provisions of the "Manual for Control of Government Property in Possession of Contractors" (Appendix B, Armed Services Procurement Regulation), as in effect on the date of this purchase order, which Manual is hereby incorporated by reference and made a part hereof.

(d) The Grumman-Furnished Property and/or Government Property provided or furnished pursuant to the terms of this purchase order shall, unless otherwise provided herein, be used only for the performance of this purchase order.

(e) Vendor shall maintain and administer in accordance with sound industrial practice a program for the maintenance, repair, protection and preservation of Grumman-Furnished Property and/or Government Property so as to assure its full availability and usefulness for the performance of this purchase order. Vendor shall take all reasonable steps to comply with all appropriate directions or instructions which Grumman or the Government may prescribe as reasonably necessary for the protection of Grumman-Furnished Property and/or Government Property.

(f) Vendor shall be liable for loss or destruction of or damage to Grumman-Furnished Property and/or Government Property in its possession or control in connection with the work to be performed under this purchase order. Vendor is required to return all Grumman-Furnished Property and/or Government Property in as good condition as when received, except for reasonable wear and tear or for the utilization of the property in accordance with the provisions of this purchase order.

(g) Grumman and/or the Government shall be at reasonable times have access to the premises where any of the Grumman-Furnished Property or Government Property is located.

(h) The Grumman-Furnished Property and/or Government Property shall remain in possession of Vendor for such period of time as is required for the performance of this purchase order unless Grumman determines that the interests of Grumman or the Government require removal of such property. In such case Vendor shall promptly take such action as Grumman may direct with respect to the removal and shipping of such property. In any such instance, this purchase order may be amended to accomplish an equitable adjustment in the terms and provisions hereof.

ARTICLE 10 - (i) (Continued)

(i) Upon completion of this purchase order, or at such earlier dates as may be fixed by Grumman, Vendor shall submit to Grumman in a form acceptable to Grumman, inventory schedules covering all items of Grumman-Furnished Property and/or Government Property not consumed in the performance of this purchase order, or not theretofore delivered to Grumman, and shall deliver or make such other disposal of such Grumman-Furnished Property and/or Government Property as may be directed or authorized by Grumman. The net proceeds of any such disposal shall be credited to the cost of the work covered by this purchase order or shall be paid in such manner as Grumman may direct. The foregoing provisions shall apply to scrap from Grumman-Furnished Property and/or Government Property; provided, however, that Grumman may authorize or direct Vendor to omit from such inventory schedule any scrap consisting of cutting and processing waste, such as chips, cuttings, borings, turnings, short ends, circles, trimmings, clippings, and remnants, and to dispose of such scrap in accordance with Vendor's normal practice and account therefor as a part of general overhead or other reimburseable costs in accordance with Vendor's established accounting procedures.

(j) Unless otherwise provided herein, Grumman shall not be under any duty or obligation to restore or rehabilitate, or to pay the cost of the restoration or rehabilitation of Vendor's plant or any portion thereof which is affected by the removal of any Grumman-Furnished Property and/or Government Property.

(k) (1) Within 60 days after delivery of the first unit(s) of supplies called for in this purchase order, Vendor shall submit to Grumman a list of tools completed as of the delivery of the first unit, detailing the quantity, the description, tool number and the individual cost (reasonably estimated if necessary) of each tool together with the part number for which it is used. Vendor shall identify all tools using Grumman Tool and Equipment Codes. Vendor may use own existing identification system, in addition thereto.

(2) Thereafter, Vendor shall submit quarterly (not later than 30 days after the end of the month of each calendar quarter) a similar list of tools which have been completed since the submission of the previous list. If there are no additional completed tools to report at the date of quarterly submission, a statement to that effect will be submitted. The completion invoice shall be accompanied by a list of any tools completed and not previously reported.

(3) Each list shall be certified as follows:

"We certify that we, as custodian, are accountable to Grumman for the above tools, that they are the property of the U.S. Government, that they have been so identified, and that they are available for inspection by Government Representatives."

ARTICLE 11 - PATENTS AND DATA

(a) The clauses contained in the following paragraphs of NASA PR or other NASA documents as in effect on the date of this purchase order (or as otherwise indicated below or in the VR, are incorporated herein by reference and made a part hereof: 9.105, Notice and Assistance Regarding Patent Copyright Infringement; 9.107, Filing of Patent Applications; 9.101, Property Rights in Inventions (November 1962); 9.203-1, Rights in Data; 9.108(a), Payment of Royalties; and in order to make the content of these clauses applicable to this purchase order, the term "Contractor" shall mean Vendor, the term "Contract" shall mean this purchase order, the term "Contracting Officer" in 9.105 and 9.203-1(d) shall mean the Contracting Officer and Grumman; and term "government" in 9.203-1 shall mean Government and Grumman. Vendor agrees to and pursuant to such clause but only to the extent necessary to enable Grumman to fulfill its obligations under the prime contract.

(b) Rights in Photographic Data

(1) The term "Photographic Data" as used herein includes writings, sound recordings, pictorial reproductions, drawings or other graphical representations, and works of any similar nature (whether or not copyrighted) which are specified to be delivered elsewhere in this purchase order. The term does not include financial reports, cost analyses, and other information incidental to purchase order administration.

(2) All Photographic Data first produced in the performance of this purchase order shall be the sole property of the Government. The Vendor agrees not to assert any rights at common law or equity and not to establish any calim to statutory copyright in such Photographic Data. The Vendor shall not publish or reproduce such Photographic Data in whole or in part or in any manner or form, nor authorize other so to do, without the written consent of the Government until such time as the Government may have released such Photographic Data to the public.

(3) The Vendor agrees to grant and does hereby grant to the Government and its officers, agents and employees acting within the scope of their official duties, a royalty-free, nonexclusive, and irrevocable license throughout the world (i) to publish, translate, reproduce, deliver, perform, use and dispose of, in any manner, any and all Photographic Data not first produced or composed in the performance of this purchase order but which is incorporated in the work specified to be delivered under this purchase order; and (ii) to authorize others so to do.

ARTICLE 11 - (b) (Continued)

(4) The Vendor shall indemnify and save and hold harmless Grumman and the Government, their officers, agents and employees acting within the scope of their official duties against any liability, including costs and expenses, (i) for violation of proprietary rights, copyright or right of privacy, arising out of the publication, translation, reproduction, delivery, performance, use or disposition of any Photographic Data furnished under this purchase order or (ii) based upon any libelous or other unlawful matter contained in such Photographic Data.

(5) Nothing contained in this clause shall imply a license to Grumman or the Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government under any patent.

(6) Paragraphs (3) and (4) above are not applicable to material furnished to the Vendor by Grumman and incorporated in the work furnished under the purchase order; provided, such incorporated material is identified by the Vendor at the time of delivery of such work.

(c) Reporting of New Technology

(1) As used in this clause and in the Property Rights in Inventions clause which is incorporated in this purchase order, the following terms have the meanings assigned:

(A) "Reportable item" means any invention, discovery, improvement or innovation, whether or not the same is susceptible of protection under the United States patent laws, which is made in the performance of work under this purchase order or in the performance of any work done upon an understanding in writing that this purchase order would be awarded;

(B) "Made" means conceived or first actually reduced to practice, and "making" means conceiving or first actually reducing to practice;

(C) "Invention" means any reportable item which appears to fall within a statutory class of patentable subject matter (35 U.S.C. 101 and 171) and which has a reasonable possibility of being patentable;

(D) "Subcontract" and "subcontractor" means any subcontract or subcontractor of the Vendor, and includes any lower-tier subcontract or subcontractor under this purchase order;

ARTICLE 11 - (c) (Continued)

(E) When this clause and the Property Rights in Inventions clause are included in any subcontract, "Contractor" shall be read as "subcontractor" and "contract" shall be read as "subcontract";

(F) "Person" means any individual, partnership, group, corporation, association, institution or other entity; and

(G) "Administrator" includes the Administrator of NASA and his duly authorized representative.

(2) Vendor shall conduct a continual review of the results of the work performed under this purchase order for the purpose of identifying reportable items and shall furnish promptly to Grumman a written report concerning each reportable item. Such a report shall include:

(A) Such technical detail as is necessary to identify, describe and convey an understanding of the nature, purpose, operation and physical (electrical, chemical, etc.) characteristics of each reportable item;

(B) A designation of each reportable item considered by the Vendor to constitute an invention;

(C) A statement which sets forth the relationship of each reportable item to the present purchase order work; and

(D) A statement of all apparent uses in which each reportable item may find application.

(3) In addition to the report required in (2) above, the Vendor shall furnish to Grumman within one month following each semi-annual anniversary date of this purchase order a summary of the review activities undertaken and the results thereof which shall include:

(A) A written report as required by (2) above for each reportable item not previously reported.

(B) A statement listing each subcontract containing this Reporting of New Technology clause and the Property Rights in Inventions clause, stating the name and address of each subcontractor, describing the work to be performed, and giving the estimated completion date of each subcontract.

ARTICLE 11 - (c) (Continued)

(4) After completion of the purchase order and prior to final payment, Vendor shall furnish a report:

(A) Listing all reportable items or certifying that there were no reportable items; and

(B) Confirming or correcting previous information submitted regarding subcontracts, or certifying that no such subcontracts were awarded.

(5) (A) In each subcontract hereunder involving research, experimental, design, engineering or development work, Vendor shall include the Property Rights in Inventions clause which is incorporated in this purchase order and this clause, except for paragraph (6) below.

(B) In each subcontract hereunder of over $50,000 which calls for work of the type described in (5) (A), the Vendor shall, prior to tendering final payment:

(i) Obtain from an official having authority to execute such subcontract on behalf of the subcontractor, a letter certifying the compliance by the subcontractor with this clause and the Property Rights in Inventions clause which is incorporated in this purchase order; and

(ii) Submit a copy of such letter to Grumman.

(C) In the event of refusal by a subcontractor to accept this clause and the Property Rights in Inventions clause or either of them, Vendor shall promptly notify Grumman of such refusal and shall not execute the subcontract in question until provisions have been approved in writing by Grumman for inclusion in said subcontract.

(D) Vendor shall, prior to final payment hereunder, furnish, on behalf of vendor, from an official having authority to execute such purchase order on behalf of the Vendor, a letter certifying compliance by the Vendor with this clause and the Property Rights in Inventions clause which is incorporated in this purchase order.

(6) (A) Except as provided in subparagraph (B) below, if the Vendor fails to comply with the provisions of this clause or of the Property Rights in Inventions clause which is incorporated in this purchase order, there shall be withheld from payment, until such failures have been corrected, either

ARTICLE 11 - (c) (Continued)

ten percent (10%) of the amount of this purchase order, or fifty thousand dollars ($50,000), whichever is less. After payment of eighty-five percent (85%) of the amount of this purchase order, as from time to time amended, payment shall be withheld until a reserve of either ten percent (10%) of such amount or fifty thousand dollars ($50,000), whichever is less, shall have been set aside, such reserve or balance to be retained until the Vendor shall have complied with the provisions of this clause and the Property Rights in Inventions clause as aforesaid. In the event that Vendor does not comply with the provisions aforesaid within one year after final payment (exclusive of the amount withheld) of this purchase order, any amount actually withheld under the provisions of this purchase order and authorized to be withheld under this paragraph (6) shall be deemed to be liquidated damages for noncompliance with this clause. No amount shall be withheld under this paragraph (6) so long as the amount specified in this paragraph (6) is being withheld under the provisions of this purchase order. The payment of any amount or withholding thereof under this paragraph (6) shall not be construed as a waiver of any rights accruing to the Government under this purchase order.

(B) Subparagraph (A) does not apply when the purchase order is a no fee purchase order with an educational institution. In no fee contracts with nonprofit institutions other than educational institution, the percentage amount specified to be withheld in subparagraph (A) above is reduced from ten percent (10%) to one percent (1%).

(7) The Government may duplicate, use and disclose in any manner and for any purpose whatsoever, and have others so do, all reports required by paragraphs (2) and (3) of this clause.

(d) The prime contract contains an Authorization and Consent clause, as defined in NASA PR 9.103(b), the benefits of which extend to this purchase order, or any part hereof, or any amendment hereto, or any subcontract hereunder (including any lower-tier subcontract).

(e) None of the supplies furnished hereunder or tools used for producing such supplies, if specially designed for or by Grumman, shall be duplicated for others without the prior written consent of Grumman.

ARTICLE 12 - TRANSFER OR ASSIGNMENT PROHIBITED, SUBCONTRACTING LIMITED

(a) This purchase order shall not, nor shall any interest therein, be assigned or transferred by Vendor to any corporation, partnership, individual or others without the prior written consent of Grumman.

(b) Vendor shall not, without the prior written consent of Grumman, place any subcontract which:

(1) Is on a cost-plus-a-fee, time and material, or labor-hour basis; or

(2) Is on a fixed price basis exceeding in dollar amount $25,000; or

(3) Is for the fabrication, purchase, rental, installation or other acquisition, of any item of industrial facilities, or is for special tooling, having a value in excess of $1,000.

Grumman may, in its discretion, ratify in writing any such subcontract; such action shall constitute the consent of Grumman as required by this paragraph (b).

(c) No subcontract placed under this purchase order shall provide for payment on a cost-plus-a-percentage-of-cost-basis.

(d) When a subcontract is within the provisions of paragraph (b), above and involves an amount estimated to be $100,000 or more or may be anticipated to aggregate $100,000 or more with add-ons, Vendor shall submit a procurement plan at least twenty days prior to Vendor issuing any request for quotation which shall contain:

(1) A detailed statement of the proposed scope of work.

(2) An invitation list, the criteria used in establishing the list and the proposed method of selecting the subcontractor.

(3) The estimated dollar value of the proposed procurement and the projected dollar value which may normally be expected to result from this procurement.

(4) The type of subcontract, i.e., Cost, Cost-Plus-Fixed-Fee, Fixed Price, etc.

(5) The estimated period of performance and, where such period extends beyond the period for which funds are allotted to this purchase order, the proposed limitation upon funds payable under the subcontract.

ARTICLE 12 - (d) (Continued)

(6) A statement of the rights to data accruing to the National Aeronautics and Space Administration under the proposed subcontract.

(7) A statement of the Rights of Access to subcontractor's plants by other prime contractors.

(8) The reporting requirements to be included in the proposed subcontract.

(9) Items of unusual nature pertaining to this proposed subcontract and all other information necessary to present a complete picture of the proposed procurement.

No arrangement as to subcontract award of those subcontracts described in this paragraph (d) shall be made by Vendor prior to receipt of consent from Grumman. The above information shall be submitted upon request on any other proposed subcontract referred to in (b) above.

(e) The Vendor shall give Grumman immediate notice in writing of any action or suit filed, and prompt notice of any claim made against the Vendor by any subcontractor or Vendor which, in the opinion of the Vendor, may result in litigation, related in any way to this purchase order with respect to which the Vendor may be entitled to reimbursement from Grumman.

(f) The Vendor shall (i) insert in each price redetermination or incentive price revision subcontract hereunder the substance of the "Limitation on Payments" provision set forth in paragraph (j) of the clause described by Section 7.108 of the NASA Procurement Regulation, including subparagraph (4) thereof, modified to omit mention of the Government and reflect the position of the Vendor as purchaser and of the Government and reflect the position of the Vendor as purchaser and of the subcontractor as Vendor, and to omit that portion of subparagraph (3) thereof relating to tax credits, and (ii) include in each cost-reimbursement type subcontract hereunder a requirement that each price redetermination and incentive price revision subcontract thereunder will contain the substance of the "Limitation on Payments" provision, including subparagraph (4) thereof, modified as outlined in (i) above.

(g) To facilitate small business participation in subcontracting under this purchase order, the Vendor agrees to provide progress payments on the fixed price types of subcontracts of those subcontractors which are small business concerns, in conformity with the standards for customary progress stated in paragraphs 503 and 514 of Appendix E

ARTICLE 12 - (g) (Continued)

of the Armed Services Procurement Regulation, as in effect on the date of this purchase order. The Vendor further agrees that the need for such progress payments will not be considered as a handicap or adverse factor in the award of subcontracts.

(h) The substance of paragraphs (d), (e) and this paragraph (h) shall be included in each subcontract hereunder which involves an amount estimated to be $100,000 or more or may be anticipated to aggregate $100,000 or more with add-ons, modified to reflect the position of subcontractors or vendors.

ARTICLE 13 - ADDITIONAL NATIONAL AERONAUTICS AND SPACE ADMINISTRATION PROCUREMENT REGULATIONS, CLAUSES

(a) The contract clauses contained in the following paragraphs of the NASA PR, as in effect on the date of this purchase order, are incorporated herein by reference and made a part hereof: 1.307.2 Priorities, Allocations and Allotments; 1.707-3(b), Small Business Subcontract Programs; 6.104-5, Buy American Act; 7.103-13, Renegotiation; 7.103-19, Officials not to Benefit; 1.503, Covenant Against Contingent Fees; 7.104-4, Notice to the Government of Labor Disputes; 7-104.11(a), Excess Profit; 7.204-12 Security Requirements; 1.707-3(a), Utilization of Small Business Concerns; 7.104-20, Utilization of concerns in Labor Surplus Areas; 7.203-7, Records; 12.203, Convict Labor; 12.604, Walsh-Healey Public Contracts Act; 12.802, Nondiscrimination in Employment.

In all such clauses, where necessary to make the context applicable to this purchase order, the term "Contractor" and equivalent phrases shall mean "Vendor," and the terms "Government" and "Contracting Officer" and equivalent phrases shall mean "Grumman".

(b) Contract Work Hours Standards Act - Overtime Compensation

This purchase order, to the extent that it is of a character specified in the Work Hours Act of 1962 (Public Law 87-581, 76 Stat. 357-360) and is not covered by the Walsh-Healey Public Contracts (41 U.S. Code 35-45), is subject to the following provisions and to all other provisions and exceptions of said Work Hours Act of 1962.

(1) Overtime requirements

No Vendor or subcontractor contracting for any part of the purchase order work shall require or permit any laborer or mechanic to be employed on such work in excess of eight hours in any calendar day or in excess of forty hours in any workweek unless such laborer or mechanic receives compensation at a rate not

ARTICLE 13 - (b) (Continued)

less than one and one-half times his basic rate of pay for all hours worked in excess of eight hours in any calendar day or in excess of forty hours in such workweek, whichever is the greater number of overtime hours.

(2) Violations; liability for unpaid wages; liquidated damages

In the event of any violation of the clause set forth in paragraph (1), the Vendor and any subcontractor responsible therefore shall be liable to any affected employee for his unpaid wages. In addition, such Vendor or subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed, with respect to each individual laborer or mechanic employed in violation of the clause (1), in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of eight hours or in excess of forty hours in a workweek without payment of the overtime wages required by the clause (1).

(3) Withholding for unpaid wages and liquidated damages

The Federal agency for which the purchase order work is done or by which financial assistance for the work is provided may withhold, or cause to be withheld, from any monies payable on account of work performed by the Vendor or subcontractor, the full amount of wages required by the purchase order and such sums as may administratively be determined to be necessary to satisfy any liabilities of such Vendor or subcontractor for liquidated damages as provided in clause (2).

(4) Insertion of clauses in subcontracts

The Vendor agrees to insert the foregoing clauses (1), (2) and (3), and this clause (4), in all subcontracts.

ARTICLE 14 - LIMITATION OF REPORTS

The reporting requirements of this purchase order are subject to the Government Printing and Binding Regulations published by the Joint Committee on Printing, Congress of the United States, and the Vendor shall be governed accordingly.

ARTICLE 15 - LIMITATION OF GRUMMAN'S OBLIGATION

(a) It is estimated that the total cost to Grumman, inclusive of any fixed fee, for the performance of this purchase order will not exceed the estimated cost and fixed fee set forth in the Schedule and the Vendor agrees to use its best efforts to perform the work specified in the Schedule and all obligations under this purchase order within such estimated cost. The fixed fee for complete performance of this purchase order is specified in the Schedule.

(b) The sum presently available for payment and allotted to this purchase order, the items covered thereby and the period of performance which it is estimated the allotted amount will cover, are specified in the Schedule. It is anticipated that from time to time additional funds will be allotted to this purchase order up to the full estimated cost, including any fixed fee. When additional funds are allotted from time to time for continued performance of the work, the parties shall agree as to the applicable estimated period of purchase order performance which shall be covered by such funds and the purchase order Schedule amended accordingly. The Vendor agrees to perform or have performed work on this purchase order up to the point at which in the event of termination of the purchase order for the convenience of Grumman or the Government pursuant to the clause of this purchase order entitled "Termination," the total amount paid and payable by Grumman pursuant to any settlement including cost and fixed fee under paragraph (e) of such clause would, in the exercise of reasonable judgment by the Vendor, approximate the total amount at the time allotted to this purchase order. The Vendor shall not be obligated to continue performance of the work beyond such point.

(c) Grumman shall not be obligated to reimburse the Vendor for costs incurred (including amounts payable in respect to subcontracts and termination settlement costs) and to pay any fixed fee to which the Vendor may be entitled in excess of the total amount from time to time allotted to this purchase order. However, when and to the extent that the total amount allotted to this purchase has been increased, any costs incurred by the Vendor and any fixed fee to which the Vendor may be entitled, prior to the increase and in excess of the amount previously allotted shall be allowable to the same extent as if such costs had been incurred and fee earned after such increase in amount allotted

(d) In the event funds allotted are considered by the Vendor to be inadequate to cover the work to be performed for the period set forth in the Schedule, the Vendor shall notify Grumman in writing when within the next thirty (30) days the work will reach a point, at which, in the event of termination of this purchase order for the convenience of Grumman or the Government pursuant to the clause of this purchase order entitled "Termination" the total amount paid and payable by Grumman pursuant to a settlement including cost and

ARTICLE 15 - (d) (Continued)

fixed fee under paragraph (e) of such clause will approximate eighty-five percent (85%) of the total amount then allotted to the purchase order. The notice shall state the estimated date when such point will be reached and the estimated amount of additional funds required to continue performance for the period set forth in the Schedule. The Vendor shall, thirty (30) days prior to the end of the period specified in the Schedule, advise Grumman in writing as to the estimated amount of additional funds which will be required on the basis of the obligation for performance in accordance with paragraph (b) of this clause, for the timely performance of the work under the purchase order for such further period as may be specified in the Schedule or otherwise agreed to by the parties. If, after such notification, additional funds are not allotted by the end of the period set forth in the Schedule, or an agreed date in substitution therefore, Grumman will, upon written request of the Vendor, terminate this purchase order on such date, or on a date to be specified in such request, on which the Vendor, in the exercise of his reasonable judgment, estimates that he will have discharged his obligation to perform hereunder in accordance with paragraph (b) of this clause, whichever is later, pursuant to the provisions of the clause of this purchase order entitled "Termination."

(e) When additional funds are allotted from time to time for continued performance of the work under this purchase order, the parties shall agree as to the applicable period of purchase order performance which shall be covered by such funds, and the provisions of paragraph (b), (c), and (d) of this clause shall apply in like manner to such additional allotted funds and substituted date pertaining thereto, and the purchase order shall be amended accordingly.

(f) Grumman may at any time prior to termination allot additional funds, for this purchase order, and, with the consent of the Vendor, after notice of termination, may rescind such termination in whole or in part, and allot additional funds for this purchase order.

(g) In the event that sufficient amounts are not allotted to this purchase order to allow completion of the work contemplated by this purchase order, theVendor shall be entitled, subject to the limitations of paragraph (c) of this clause, to a percentage of the fixed fee set forth in the Schedule equivalent to the percentage of completion of the work contemplated by this purchase order.

(h) Nothing in this clause shall affect the right of Grumman to terminate this purchase order pursuant to the clause of this purchase order entitled "Termination."

ARTICLE 15 - (i) (Continued)

(i) For the purpose of this clause, the allotment(s) specified in the Schedule shall not be decreased without the consent of the Vendor.

(j) This clause shall be applicable and the clause of this purchase order entitled "Limitation of Cost" inapplicable until such time as an amount equal to the total estimated cost and fee set forth in the Schedule is allotted to this purchase order and thereafter the clause of this purchase order entitled "Limitation of Cost" shall be applicable and this clause inapplicable.

ARTICLE 16 - DATA REQUIREMENTS

(a) To the extent that the following data are not elsewhere required to be furnished to Grumman under this purchase order, and is of the type retained by Vendor in the normal course of business, the Vendor, upon written request of Grumman at any time during purchase order performance or within one year after final payment to Grumman under the prime contract, shall furnish the following:

(1) A set of engineering drawings necessary to enable reproduction or, where appropriate, manufacture of any equipment or items furnished under the purchase order (other than components or items of standard commercial design or items fabricated heretofore); or a set of flow sheets and engineering drawings necessary to enable performance of any process developed under the purchase order. Such set(s) of drawings and flow sheets shall be reproducible copies incorporating all changes made in the equipment or process in the form in which it was delivered to Grumman.

(2) Any of the following data which are necessary to explain or help Grumman technical personnel understand any equipment, items or process developed under the purchase order and furnished to Grumman:

(A) A copy (which shall be a reproducible master if one is so requested) of drawings and other technical data used in or prepared in connection with the development, practice and testing of any process or processes required under the purchase order, or with the development, fabrication, (other than items of standard commercial design or items fabricated heretofore), is required under the purchase order.

(B) A report of all studies made in planning the work, and in developing background research for the work, including citation references to all such background research, and

ARTICLE 16 - (a) (Continued)

a copy of all compilations, digests or analyses of such background research compiled in connection with the performance of this purchase order.

(C) A copy (which shall be a reproducible master if one is so requested) of design studies, research notes, parameter and tolerance studies, drawings, including Vendor's indentification of symbols and markings, specifications, test results and any other technical information used in any research, development, design, engineering, and testing required in the performance of this purchase order, including test equipment and related items, together with any information as to safety precautions which may be necessary in connection with the manufacture, storage, or use of the equipment, material, or process, if any, in the event that any equipment, material or process is the subject of research under this purchase order. The Vendor shall not be required to furnish any background data which may be described in (B) or (C) above unless such data are essential and closely related to the purchase order work.

(b) All reports, data, and recorded information which are required to be furnished by the Vendor under this provision, as well as all other reports of a technical nature required to be furnished under this purchase order, are "Subject Data" within the meaning of the clause incorporated by reference in this purchase order entitled "Rights in Data".

(c) Nothing contained in this "Data Requirements" clause shall require the Vendor to deliver (1) any data, the delivery of which is excused by paragraph (i) of the clause incorporated by reference in this purchase order entitled "Rights in Data"; or (2) data previously developed by parties other than the Vendor, independently of this purchase order and acquired by Vendor prior to this purchase order under conditions restricting Vendor's right to disclose the same. If any of the data requested is in the public domain or copyrighted, it will be sufficient for the Vendor to identify the data and furnish a citation as to where it may be found.

(d) Any reproducible copies requested under this "Data Requirements" article shall be of a type and prepared in accordance with good commercial practice.

(e) In the event Grumman requests the delivery of data by the Vendor, as contemplated by (a) above, prior to final payment, such request shall be treated as a change under the clause of this purchase order entitled "Changes" and an equitable adjustment in the estimated

ARTICLE 16 - (e) (Continued)

cost and any fixed fee shall be made to cover the cost of preparing drawings called for in (a) (1) above, and of collecting, preparing, editing, duplicating assembling, and shipping the date requested under (a) above, but only to the extent that the Vendor warrants that such costs were not included in the estimated cost and fixed fee of the purchase order. The Vendor shall comply with requests of Grumman made under (a) above, within one year following final payment to Grumman under the Prime Contract, provided, that suitable provision is made for reimbursement of the additional costs of complying with such request, together with a reasonable fee, such additional costs being limited to the costs set forth above, and warranted to have been excluded from the estimated cost and fixed fee of the purchase order. Any adjustment or payment under this paragraph (e) shall not include any amount for the value of the data, as distinguished from the costs set forth above.

ARTICLE 17 - VENDOR'S INDEPENDENT RESEARCH PROGRAMS

Any invention made in the performance of any work by the Vendor under the Vendor's own product improvement program or the Vendor's independent research program, even though supported by an allowance of costs for such program as a part of the overhead costs hereof, will not be subject to the "Property Rights in Inventions" clause of this purchase order unless said work is identified in wiring as being requested in the performance of this purchase order.

ARTICLE 18 - INCENTIVE PROVISIONS

(a) Grumman shall have the right, upon written notice to the Vendor, to require the Vendor to enter into negotiations concering the incorporations of appropriate incentive provisions into the purchase order.

(b) The Vendor may request at any time that negotiations be entered into concerning appropriate incentive provisions.

(c) If such negotiations result in an agreed incentive provision, it will be incorporated herein by an amendment to the purchase order.

ARTICLE 19 - PLACE OF PERFORMANCE

(a) The Vendor shall perform all work called for herein at the Vendor's plants as set forth elsewhere in this purchase order except for work to be accomplished by subcontractors.

(b) The Vendor shall promptly notify Grumman of any contemplated change in location for the performance of work from the locations designated above. Prior approval of Grumman shall be obtained by the Vendor before making any change in location for the performance of work herein, if the cost of performing such work is estimated to exceed $50,000.

ARTICLE 20 - VISITS TO VENDOR'S PLANTS

Authorized representatives of Grumman and NASA shall have the right to visit the Vendor's and its subcontractors' plant(s) at any time during the performance of this purchase order for the purpose of making any inspections or obtaining any information. Prior notification of such visits shall be given Vendor's personnel to minimize interference with normal operations of such plant(s).

ARTICLE 21 - RELEASE OF NEWS INFORMATION

No news release, public announcement, denial or confirmation of some or part of the subject matter of this purchase order or any phase of any program hereunder shall be made without the prior approval of Grumman.

ARTICLE 22 - VENDOR AND SUBCONTRACTOR COST OR PRICING DATA

(a) (1) The vendor shall require, under the situations described in (2) below, unless exempted under the exceptions set forth in (3) below, each subcontractor under this purchase order to submit cost or pricing data and to certify that, to the best of his knowledge and belief, such cost or pricing data are accurate, complete and current.

(2) The cost or pricing data called for under (1) above shall be submitted prior to (i) the award of each subcontract the price of which is expected to exceed $100,000 and (ii) the pricing of each change or modification to a subcontract under this purchase order for which the price adjustment is expected to exceed $100,000.

(3) Cost or pricing data need not be furnished pursuant to this paragraph (2) where (i) Vendor has not been required to furnish cost or pricing data and to certify that it is accurate, complete and current; and (ii) the price or price adjustment is based on adequate price competition, established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation.

(4) In submitting the cost or pricing data, the subcontractor shall use the form of certificate set forth in paragraph (b) below and certify that the data are accurate, complete and current as of a date prior to and as close as practicable to the date of award of the subcontract or to the date of the price adjustment of any change or modification. Such cost or pricing data and certificate of current cost or pricing data shall be submitted by subcontractors to the Vendor (or, to their immediate next higher tier subcontractor, for delivery to Grumman through successive higher tiers of subcontractors).

ARTICLE 22 - (b) (Continued)

(b) The certificates required by this clause shall be in the form set forth below. The second date shown in the certificate shall be prior to and as close as practicable to the date of agreement of the related negotiated price or price adjustment. When the certificate is to be submitted by a subcontractor, the words "Grumman or its representative" shall be deleted and the name of the firm requiring the certificate shall be inserted. Title 10 U.S.C. Section 1001 prescribes criminal penalties for making false representations to the Government.

CONTRACTOR'S CERTIFICATE OF CURRENT COST

OR PRICING DATA (November 1962)

This is to certify that, to the best of my knowledge and belief:

(i) complete pricing data or cost data current as of _____ Date

have been considered in preparing the _____ Describe the proposal,

_____

quotation, request for price adjustment, or other submission

_____

involved giving appropriate identifying number, e.g., REP No.)

and submitted to Grumman or its representative;

(ii) all significant changes in the above data through _____ Date

have been similarly submitted; and no more recent significant change in such data was known to the undersigned at the time of executing this certificate; and

(iii) all of the data submitted are accurate.

NAME _____

TITLE _____

FIRM _____

_____

Date of Execution

ARTICLE 22 - (c) (Continued)

(c) For purposes of verifying that cost or pricing data required to be submitted and certified to, either during negotiation of this purchase order or pursuant to the provisions of this clause are accurate, complete, and current, the Contracting Officer, or his authorized representatives, shall - until the expiration of three years from the date of final payment under this purchase order - have access to and the right to examine those books, records, documents and other evidence which will permit adequate evaluation and projections used therein, which were available to the Vendor as of the date of execution of the Contractor's Certificate of Current Cost or Pricing Data.

(d) Whenever the price of any change or modification to this purchase order is expected to exceed $100,000, except where the price is based on adequate price competition, established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation, the Vendor agrees to furnish Grumman cost or pricing data and shall certify, using the certificate set forth in paragraph (b) above, that to the best of his knowledge and belief such cost or pricing data are accurate, complete and current as of a date prior to and as close as practicable to the date of agreement of the price adjustment.

(e) The Vendor agrees to insert paragraph (c), without change, and the substance of paragraphs (a), (b), (d) and (e) of this clause in each subcontract hereunder in excess of $100,000, and in each subcontract of $100,000 or less at the time of making a change of modification thereto in excess of $100,000.

(f) Whenever the Vendor was required to furnish a certificate of current cost or pricing data, either during negotiation of this purchase order or pursuant to the provisions of this clause, or whenever a lower-tier subcontractor hereunder was required to furnish such a certificate pursuant to the provisions of this clause or of a clause in any subcontract hereunder and the Contracting Officer determines that the price of the prime contract, including any profit or fee, or that any price adjustment negotiated for any change or mofification to the prime contract, has been increased by any significant sums because Vendor's cost or pricing data was inaccurate or incomplete or was not current as of the date set forth in the certificate applicable to such data and such price or price adjustment shall be reduced accordingly and the prime contract shall be modified in writing to reflect such reduction then in the event of any such reduction in the prime contract, the purchase order price, including any profit or fee shall be reduced in an amount to reflect the above reduction, exclusive of any Grumman fee contained in such reduction, and the purchase order shall be modified in writing accordingly.

ARTICLE 23 - LIMITATION ON WITHHOLDING OF PAYMENTS

If more than one clause or schedule provision of this purchase order authorizes the temporary withholding of amounts otherwise payable to the Vendor for supplies delivered or services performed, the total of the amounts so withheld at any one time shall not exceed the greatest amount which may be withheld under any one such clause or schedule provision at that time; provided, that this limitation shall not apply to --

(1) Withholding pursuant to any clause relating to wages or hours of employees;

(2) Withholding not specifically provided for by this purchase order; and

(3) The recovery of overpayments.

ARTICLE 24 - LAW GOVERNING

This purchase order shall be governed by and construed according to the laws of the Sate of New York.

ARTICLE 25 - REPORT ON NASA SUBCONTRACTS (SEPTEMBER, 1962)

(a) The Vendor agrees to submit information on NASA Form 667 to the National Aeronautics and Space Administration (Attention: Code BRP), Washington 25, D.C., substantially as follows with respect to each subcontract or modification thereof exceeding $10,000 as soon as possible after execution thereof:

(i) The name and address of the prime contractor (Grumman) and the NASA prime contract number (NAS-9-1100).

(ii) The name and address of the subcontractor (Vendor).

(iii) Whether the subcontractor is a large or small business concern.

(iv) A brief description of the subcontract work.

(v) The amount of the subcontract.

(vi) The principal location where the subcontract work is to be performed, if known.

(b) The term "subcontract" as used herein means procurement in excess of $10,000 by the Vendor of articles, materials, or services entering into the performance of this contract, except purchases, regardless of amount, of stock items, materials, or services which cannot be specifically identified with this contract."

ARTICLE 26 - SUMMARY

The terms and conditions of this purchase order set forth the entire agreement between the parties hereto and supersede all communications, representations or agreements, whether oral or written, between the parties hereto with respect to the subject matter hereof; and no agreement or understanding varying or extending the terms and conditions of this purchase order will be binding unless in writing and signed by Grumman's Manager of Procurement. No conditions stated by Vendor in accepting this purchase order shall be binding upon Grumman if in conflict with, inconsistent with, or in addition to the terms and conditions contained herein unless expressly accepted in writing signed by Grumman's Manager of Procurement. The remedies herein reserved shall be in addition to any further remedies provided in law or equity.

VENDOR REQUIREMENTS

FUEL CELL ASSEMBLY

ELECTRICAL POWER SUBSYSTEM

FOR

LUNAR EXCURSION MODULE

LVR-390-2 29 April 1963

SECTION G - INSTRUCTIONS FOR PREPARATION OF PROPOSAL

Presented herein are specific instructions for preparation of your proposal. Deviations from these requirements could be considered as a non-responsive proposal.

TABLE OF CONTENTS

PREFACE

GENERAL QUOTATION REQUIREMENTS

1. The proposal will be evaluated on the basis of its technical, management and cost merits after a complete review of all aspects of each category. The proposal evaluation factors shall include, but not be limited to the following:

   (a) Acceptability of proposed technical design and possibility of common usage.

   (b) Acceptability of the proposed test programs and reliability effort.

   (c) Performance on current and/or previous contracts.

   (d) Conformance to the quotation requirements of this Invitation to Quote.

   (e) General competence and organizational structure for the proposed effort.

   (f) Availability of qualified manpower and facilities.

2. The Terms and Conditions (Section F) forwarded with this Invitation to Quote, shall be the Conditions of Purchase should you be successful in receiving a purchase order.

3. Unnecessary elaborate brochures and other presentations beyond that sufficient to present a complete and effective proposal are not desired and may be construed as an indication of the Vendor's lack of cost consciousness.

4. Quotation is to remain firm for a period of 180 days.

5. Vendor shall provide twenty (20) copies each of the Summary, Technical and Management proposals. Ten copies of the Cost proposal are required. All proposals shall be submitted under separate covers, addressed to Quotation Control Unit, Plant 24.

6. The closing date on this Invitation to Quote is to be strictly observed. In accordance with ASPR 3-804 proposals received at the Grumman Quotation Control Room after the close of business on the date set for receipt thereof will not be considered unless:

(a) They are received before award is made; and

(b) They are sent by registered mail or by certified mail for which an official post office stamp on the original receipt for certified mail has been obtained or by telegraph; and

(c) It is determined that late receipt was due solely to either:

(1) Delay in the mails or delay by the telegraph company for which the Vendor was not responsible or

(2) Mishandling by Grumman after receipt at the Grumman Quotation Control Room.

(d) Telegraphic quotations are not considered as satisfactory criteria for submitting a quotation. In the event an established closing date has expired, the Vendor must submit a formal quotation even though he has previously submitted a Telegraphic Quotation.

7. Grumman hereby notifies all Vendors of the possibility that an award may be made without a discussion with the Vendors. The proposals should be submitted initially on the most favorable terms from a price, technical and management standpoint which the Vendor can submit to Grumman.

8. In your Quotation, state whether you have filed, or will within 60 days after issuance of a Purchase Order file the Compliance Report (Form 40) called for in Section 302 of Executive Order No. 10925.

9. In the event you receive more than one (1) Invitation to Quote for LEM equipment you shall submit independent proposals. Any cost savings to be realized by combined procurement shall be submitted as a separate proposal.

10. The vendor's proposal shall contain a statement declaring the vendor's status as small or large business as defined in ASPR.

11. Your proposal must state the intended place of contract performance, including Division, Department, etc., with appropriate address and names of responsible officials. In the event the administration of any resultant purchase order will be different than the place of performance, such information shall be clearly defined. In any event the name and address of the party responsible for all contract communications with your company must be stated.

12. Upon notification from the Subcontracts Administrator, submit one (1) copy of "Certificate of Current Pricing Data": Submittal will be requested prior to final negotiation and/or release of any Purchase Order.

13. In the event you are unsuccessful, or decline to bid in this competition, you are required to return to Grumman Aircraft Engineering Corporation, Attention: Purchasing Department, Quotation Control Unit, Plant 24, properly protected in accordance with Department of Defense Security Regulations, all classified matter received under this Invitation to Quote.

14. Any inquiries or exceptions to the entire Vendor Requirements (Section A through G) are to be submitted, in writing, with the cost proposal. They will not be accepted after the proposal has been submitted.

15. The vendor is requested to consider the use of previously developed equipment and/or systems to the extent technically feasible. Any such proposed utilization should be clearly identified in developing the "make" or "buy" program structure. In addition, the vendor shall clearly indicate in the cost proposal the advantages obtained by considering as a minimum the following items:

(a) Schedule
(b) Tooling Costs
(c) Special Test Equipment
(d) Facilities
(e) Reliability
(f) Ultimate Unit Cost Advantage

VOLUME I

SUMMARY PROPOSAL

1. GENERAL

The intent of this volume is to present in a few pages a summary for management type review of the program proposed. The summary volume should include no information that has not already been presented in more detail in the subsequent technical, business management, or cost estimate and cost control proposals. This volume shall be limited to twenty-five (25) 8.5 x 11 inch equivalent pages using 12 point elite type.

1.1 Technical Approach Summary. - This section should in essence be the technical approach summary paragraph presented in the technical proposal, Volume II, paragraph 2.1.

1.1.1 This portion of the summary report should include but not be limited to:

(a) Program schedule

(b) Test plan summary

(c) Configuration layout

(d) Schematic and/or functional block diagram

(e) Performance summary table and/or curves

(f) Specific technical experience in the area of research, development and production of similar equipment that the vendor feels makes him the most suited for this program.

1.2 Business Management Summary. - This section should include as a minimum (a) table of the vendor's past experience and performance, (b) organization chart(s) as specifically pertaining to this program in addition to the corporate organization relationship, (c) summary of the facilities that are required for this program and how they will be provided, (d) total manpower available showing that required specifically for this program, (f) the type of cost control program he envisions necessary for this program, (g) make-or-buy structure anticipated.

SUMMARY PROPOSAL (Continued)

1.3 Vendor Deviations. - This section should list in summarized form all deviations the vendor has taken in preparation of his proposal. The detail discussion of these deviations is to be presented in Volume II.

VOLUME II

TECHNICAL PROPOSAL

2. GENERAL

The technical proposal represents the information required to evaluate the excellence of the vendors technical staff, technical and manufacturing facilities, and proposed solution to the technical design, manufacturing, and operational problems as defined here to support the development of the Fuel Cell Assembly. This volume shall be limited to one-hundred fifty (150) 8.5 x 11 inch equivalent pages using 12 point elite type.

2.1 Technical Approach. - This subsection shall present a brief description of the vendors technical approach.

2.2 Technical Discussion. - The technical discussion shall be in sufficient detail to demonstrate both the vendors understanding of the problems and the engineering, manufacturing, and operational skills. The vendor shall specifically discuss state-of-the-art of the Fuel Cell Assembly proposed, the research and development programs required, and their adaptness to orderly technical growth and improvement. The material presented in this technical discussion shall be prepared in such a manner that it can be evaluated separately from the business management proposal and the cost proposal. It shall be complete within itself and require no reference to other documents. In addition, the technical discussion should consist of but not be limited to the following:

(a) Problems associated with LEM Fuel Cell Assembly requirements and approach to be taken to solve them.

(b) Proposed Fuel Cell Assembly Configuration.

(c) Weight and Balance Summary as specified in 2.3.

(d) Proposed Test Program to develop the Fuel Cell Assembly through Qualification. This test program should be described in general terms for the total program of development and qualification. This should be followed by separate detail discussions of the development and the qualification test programs. Include a schedule, tests to be accomplished, and the quantities of hardware required to complete the program.

TECHNICAL PROPOSAL (Continued)

2.2 (e) Proposed Fuel Cell Assembly Program Schedule. The program schedule shall include the program milestones and events of Table G-1 and the delivery requirements of Section B. The dates presented in Table G-1 shall be used as a guide line for the overall schedule.

(f) Include a complete list of all technical deviations taken by the vendor in preparation of his proposal. The vendor shall make specific reference to the paragraph(s) taken exception to in the Design Control Specification LSP-390-2.

(g) Addition information requested in 2.4.

2.3 Weight and Balance Requirements for Proposals. -

(a) Weight is a critical factor and will be an important criteria in selecting a subcontractor.

(b) A detail weight breakdown in sufficient substantiative data to permit evaluation by Grumman, must be submitted with each bid.

(c) Upon selection of a subcontractor the bid weight or an agreed upon modification thereto shall become the specification maximum weight.

(d) The vendor shall submit a brief outline of the weight control procedures and weight control personnel. Organizational relationship to the project effort shall also be included.

(e) The vendor shall submit physical data tabulations, which will include the following information, in addition to item (b) above.

PHYSICAL DATA TABLE

Item	Weight (lbs)	Volume (in3)	Dimensions Dia. L H W	Quantity
Subassembly Total				
Assembly Total				

TECHNICAL PROPOSAL (Continued)

TABLE G-1

PROGRAM MILESTONES AND EVENTS

1.	Submit Preliminary Design
2.	Submit Prelinary Test and Development Plan
3.	Deliver Soft Mockup
4.	Deliver Hard Mockup
5.	Define GSE Requirements - 1 October 1963
6.	Deliver Thermal Mockup
7.	Deliver Experimental Model
8.	Deliver Development Model
9.	Start Assembly Qualification Tests
10.	Complete Prelinary Failure Analysis
11.	Complete Performance Profile Tests
12.	Deliver First Prototype Model
13.	Complete First Reliability Estimate
14.	Complete Component Qualification Tests
15.	Configuration Freeze - 1 June 1964
16.	Complete Final Design - 1 November 1964
17.	Deliver Last Prototype Model
18.	Complete Assembly Qualification Tests - 1 January 1965
19.	Release Final Failure Mode Analysis
20.	Release Final Reliability Report
21.	Deliver First Production Model (Ground Test)
22.	Deliver Last Production Model (Ground Test)
23.	Deliver First Production Model (Flight Test)
24.	Deliver Last Production Model (Flight Test)
25.	Final Report

TECHNICAL PROPOSAL (Continued)

2.4 Additional Information. - The vendor shall provide the information requested in the following paragraphs:

2.4.1 Recommendations on the Design Specification. - The vendor shall provide the information necessary to complete the Design Specification. The list of specific information required shall include but not be limited to the following items:

Source of Requirements	Information Required
Paragraph 3.2.2	FCA Weight
Paragraph 3.3.2.1	Transient voltage rise time of FCA
Paragraph 3.3.7	Purging pressure interval, flow rate, and temperature
Paragraph 3.3.7.1	Oxygen purge rate, hydrogen purge rate, and nitrogen purge rate
Paragraph 3.4.1.1	Operating temperature range
Paragraph 3.4.5.5.1	Critical over-temperature limit (manual)
Paragraph 3.4.5.5.2	Critical over-temperature limit (auto)
Figure 3	Stoichiometric hydrogen consumption rate
Figure 4	Total hydrogen consumption rate (consumption purge and vent)
Figure 5	Stoichiometric oxygen consumption rate
Figure 6	Total oxygen consumption rate (consumption and purge)

TECHNICAL PROPOSAL (Continued)

2.4.2 Fuel Cell Technology. -

(a) What occurs physically and chemically at the reaction sites?

(b) What are the reaction mechanisms?

(c) What are the equilibrium equations and corresponding equilibrium reactions, for both chemical reactions and energy transfer?

(d) Furnish enlarged view of reactant sites.

(e) What are the effects on:

(1) Reaction efficiency

(2) Polarization curve

(3) Fuel cell components; i.e. electrolyte, electrode, catalyst, seals, when each of the following parameters are varied:

(a) Operating temperature

(b) Reactant inlet pressure

(c) P between reactants and electrolyte (if applicable)

(d) Reactant inlet temperature

(e) P between hydrogen and oxygen (if applicable)

(f) P between oxygen and product water (if applicable)

(f) What are the nominal design limits for the parameters (a) through (f) noted in 2.4.2(e) and the effect of operating beyond these limits. Explain criteria for selecting these limits.

(g) Explain effects of leaving fuel cell on open circuit.

TECHNICAL PROPOSAL (Continued)

2.4.3 Power Growth. -

(a) Present overload capabilities of assembly and indicate design changes required in the proposed fuel cell assembly if the maximum power levels grows 25 and 50 percent.

2.4.4 Zero-g Operation. -

(a) Describe "zero-g" testing experience on the fuel cell assembly proposed or on similar fuel cell designs.

(b) Explain future test program in this critical area.

2.4.5 Radiation Effects. - Describe effects of radiation environment as noted in LSP-390-2, paragraph 3.2.8.1.2 on the FCA and its components. Describe experimental work in this area.

2.4.6 Safety Requirements. -

(a) Furnish failure effects analysis.

(b) Furnish safety analysis which describes how the proposed fuel cell design limits fires and/or explosions after a component failure allow the combination of hydrogen and oxygen.

(c) Describe experimental and development test failures i.e. fires, burnouts, etc.

(d) If applicable, explain the design approach to limit or prevent hydrogen bubbling into the product water loop when the membrane fails. Explain.

(e) Describe a test program to verify the safety characteristics of the FCA to preclude fires and explosions.

2.4.7 FCA Weights. - Furnish weight of Fuel Cell Assemblies capable of maintaining voltage regulation (29 ± 2 v dc) over the following power ranges.

(a) 350 watts to 900 watts (maximum rated power)

(b) 350 watts to 1125 watts

(c) 350 watts to 1350 watts

TECHNICAL PROPOSAL (Continued)

2.4.8 Thermal Data. -

(a) Furnish following data:

(1) Heat rejected to glycol cooling system in BTU for each mission phase.

(2) Maximum and minimum glycol inlet temperature required as a function of power output or mission phase.

(3) Cryogenic fuel minimum and maximum inlet temperatures required as a function of power output or mission phase.

(4) Water recovered and temperature and pressure of water as a function of mission phase (or power output)

(5) Actual pressure drop of the glycol through the fuel cell as a function of function of flow.

(6) A curve of watt-hours/reactant BTU (stoichiometric consumption) vs power in watts.

2.4.9 Reactant Requirements. -

(a) Furnish the flow rates in tabular form, for both two and three FCA's load sharing, for each phase as shown in the power profile, Figure G-1.

(1) Hydrogen flow rates in pph

(a) Consumption (stoichiometric)

(b) Purge

(c) Vent (if required)

(d) Total of above

(2) Oxygen flow rates in pph

(a) Consumption (stoichiometric)

(b) Purge

(c) Total of above

TECHNICAL PROPOSAL (Continued)

(b) Furnish curves of hydrogen and oxygen flow rates (consumption, purge, vent and total) versus power output for one FCA as a function of inlet temperature. Furnish the information from 5% to 150% rated power.

(c) Furnish curves of purge quantities versus reactant purities ranging from 0.99 to 0.99995.

(d) Furnish curves of purge time and time intervals between required purges versus reactant purity.

(e) What reactant diluents and contaminants are most harmful. Explain.

(f) Define oxygen and hydrogen temperatures requirements at the FCA interface.

(g) Completely define inlet transient reactant flow and pressure requirements with application of any step electrical load defined in load profile, Figure G-1. Define in terms of flow and pressure versus time.

(h) Completely define inlet transient reactant flow and pressure requirement during initiation of and during purging operation. Define in terms of flow and pressure versus time.

(i) Define effect on fuel cell output of operating reactant inlet at pressures down to 0 psia in increments of 10 psi from minimum normal operating pressure defined in LSP-390-2, paragraph 3.3.4.1 and 3.3.4.2.

(j) Define effect on fuel cell output of operating at reactant inlet temperatures from minimum normal operating to fluid cryogenic temperatures in increments of 25°F in sequence as follows:

(1) O_2 normal temperature; H_2 reducing.

(2) H_2 normal temperatures; O_2 reducing.

(3) O_2 reducing; H_2 reducing.

(k) Define length of time unit will operate if coolant flow is removed.

TECHNICAL PROPOSAL (Continued)

(l) Describe ability of fuel cell assembly design to accept maximum pressure as defined in LSP-390-2, paragraphs 3.3.4.1 and 3.3.4.2 if the pressure regulators fail in an open position.

(m) If heating element subassemblies are required, furnish the following information:

(1) Furnish reactant consumption rates for one FCA supplying all electrical power for phases 1, 2, 3, 4, 5, 7 and 8, as shown in Figure G-1. Two FCA's will be on standby and will be drawing electrical power required for maintenance of temperature.

(2) Furnish the reactant consumption rates for three FCA's supplying the electrical power for phases 1, 2, 3, 4, 5, 7 and 8 as shown in Figure G-1.

2.4.10 Reactant Consumption Rates. - Furnish reactant consumption rates as a function of power level for the three FCA configurations noted in 2.4.7. Extend the curve to cover a power range will be from 5% to 150% of maximum rated power.

2.4.11 Electrical Characteristics. - Information requested below shall be furnished for both two and three FCA's operating. Figure G-1 will be the basis for all furnished data. When two FCA units are operating, assume that all power above 1800 watts will be furnished by a battery.

(a) Power vs voltage (up to 150% rated power).

(b) Current density vs voltage.

(c) Indicate design criteria for establishing the maximum current density.

(d) Transient Characteristics:

(1) Current vs time for all power changes as shown in Figure G-1.

(2) Current vs time for application of short circuit, when the FCA is operating at the following power levels.

TECHNICAL PROPOSAL (Continued)

2.4.11 (d) (2) (a) Open circuit

(b) 251 watts

(c) 1029 watts

(d) 1800 watts

(3) Voltage vs time for all power changes as shown in Figure G-1.

(4) Voltage vs time for removal of following loads leaving the Fuel Cell Assemblies open circuited.

(a) Short circuit

(b) 1800 watts

(c) 1029 watts

(d) 251 watts

2.4.12 Furnish curves (voltage vs time) if one FCA is operating at a 350 watt level and it is subjected to the maximum load indicated in Figure G-1 for 5 seconds.

2.4.13 Furnish curves (voltage vs time) if one FCA is operating at a 900 watt level and it is subjected to the maximum load indicated in Figure G-1 for 5 seconds.

2.4.14 Steady State, Maximum Power. - Furnish information on the maximum power that the FCA can deliver in a steady state condition.

2.4.15 Short Circuit Tests. - Furnish information on short circuit tests run on the FCA. Indicate length of time short circuit tests were run and results of test. Describe an permanent damage to the FCA as a result of short circuit tests. What corrective action was necessary to repair damage caused by short circuit test?

2.4.16 Spike Loads. - The spike loads can originate from solenoid valves. An integral number of solenoid valves may operate simultaneously. The characteristics of a solenoid valve are listed below.

TECHNICAL PROPOSAL (Continued)

2.4.16	(a)	Resistance	14.1 ohms
	(b)	Inductance	29 millihenrys (closed) 25 millihenrys (open)
	(c)	Current at which poppet starts to move	1.00 amps at 30 volts dc 0.96 amps at 24 volts dc
	(d)	Number of turns	590
	(e)	Coefficient of coupling	0.81 @ 100 cps
	(f)	Coil current	2.0 amps maximum @ 28 v
	(g)	Nominal response	
		Full opening from signal	0.010 seconds
		Full closing from signal	0.005 seconds

2.4.16.1 Spike Load Capability. - Furnish information on the FCA performance (e.g. voltage vs time, current vs time, etc). if the power loads shown in Figure G-2 are added to the power loads of Figure G-1. Furnish the above information for two FCA operating and for three FCA operating.

2.4.16.2 Auxiliary Power Source. - If the FCA configurations of 2.4.16.1 are not capable of maintaining the required voltage regulation when subjected to the spike loads, indicate what auxiliary power source will be necessary to meet the requirements. Indicate method in which energy from auxiliary power source will be utilized.

2.4.17 Alternate Control Method. - As an alternate to the ESS requirements specified in LSP-390-2, furnish information on an electrical and purge control concept utilizing minimum automatic controls with maximum manual operation where applicable.

2.4.18 Electrical Power Utilization Analysis. - Complete form *LSK-390-1027 for those control components of the FCA that will require power (i.e.: parasitic power) for control of the FCA such as valves, heaters, ESS, etc.).

*See Section E.

TECHNICAL PROPOSAL (Continued)

2.4.19 Operational Data. -

(a) Define by-products of operation in terms of those to be collected and those to be disposed of. Include temperatures, flows, pressures.

(b) Describe operating sequences for starting, standby, and shutdown including any special problems in operation to avoid damage to the Fuel Cell Assembly. Restart from standby should also be described.

(c) Present complete information on operating pressures, temperatures, and flow in all parts of assembly.

(d) Describe any form of external service needed from vehicle for operation of package.

(e) Describe effect of constant acceleration loads in all directions on any liquids in the FCA. At what accelerations will any liquid leave its containment.

OCCURS DURING
PHASE 10 REF.
LSK-390-10025A

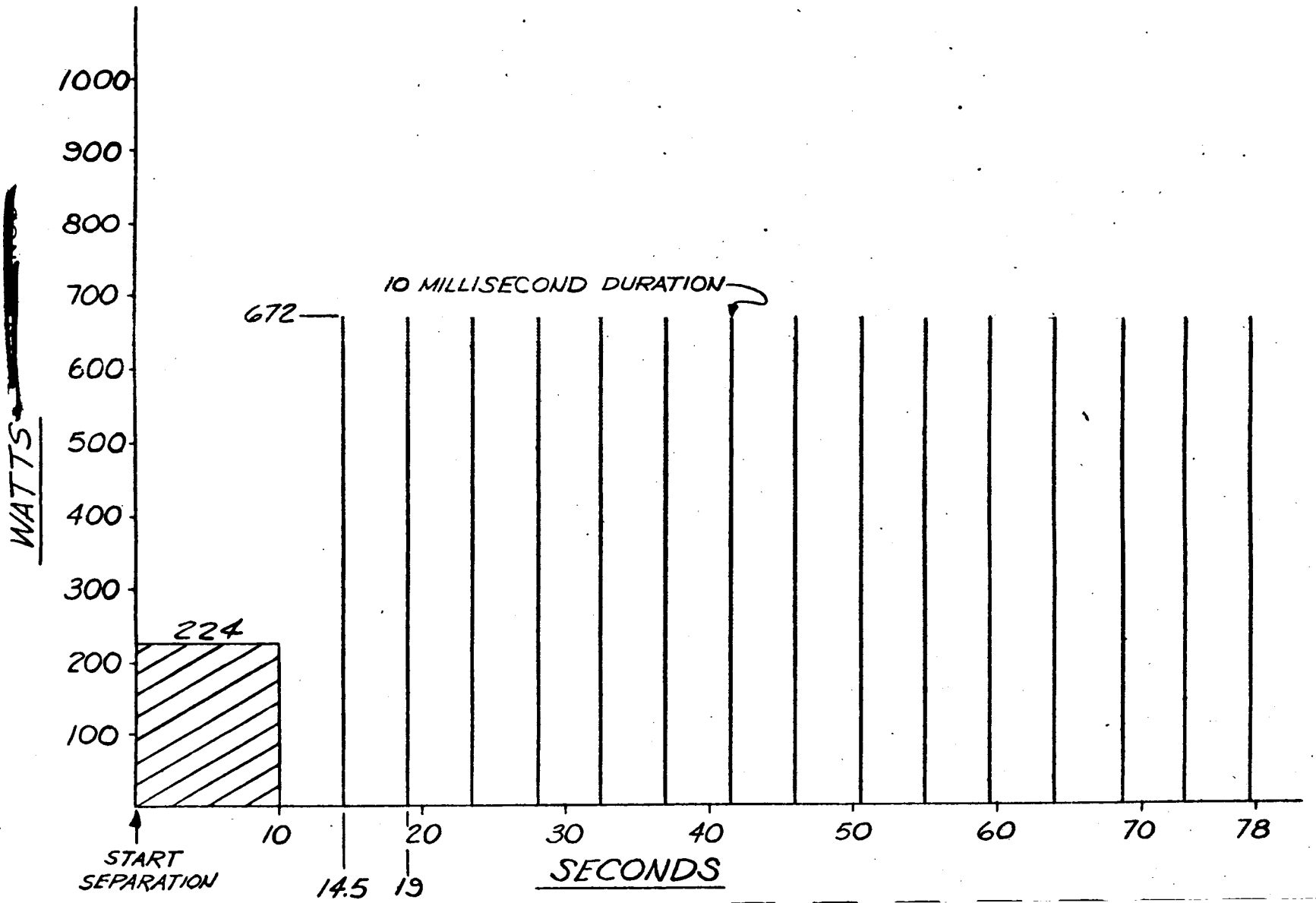
PHASE K-1

SEPARATE

1.3 MIN.

ENERGY REQ.= 0.65 WATT-HRS.

Fig. G-2 - Sheet 1



OCCURS DURING
PHASE 13 REF.
LSK-390-10025A

PHASE K-7, K-8

RETRO FROM PERICYNTHION

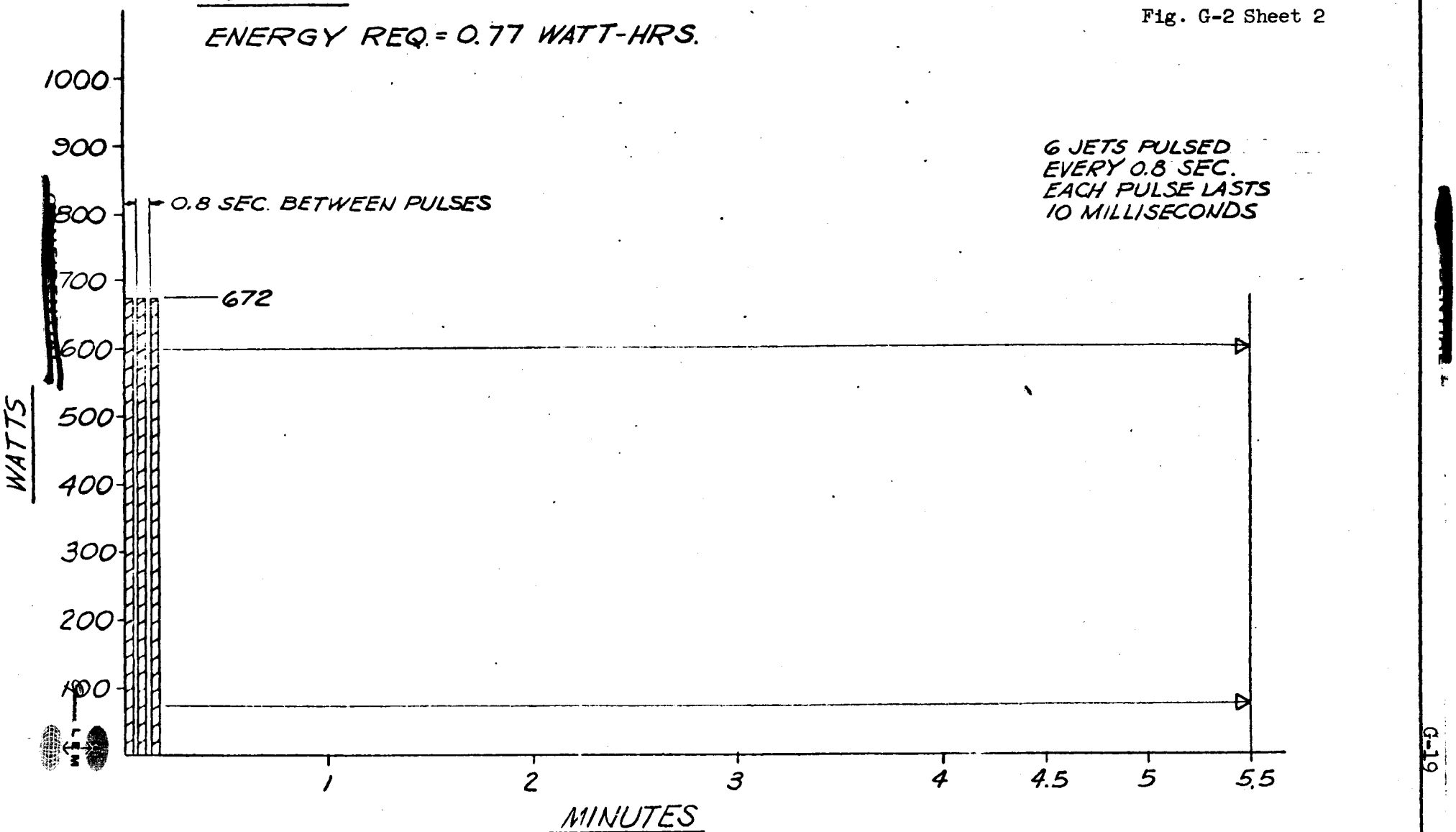
4.5 MIN.

1.0 MIN.

Fig. G-2 Sheet 2

FLARE

ENERGY REQ. = 0.77 WATT-HRS.



OCCURS DURING
PHASE 13 REF.
LSK-390-10025A

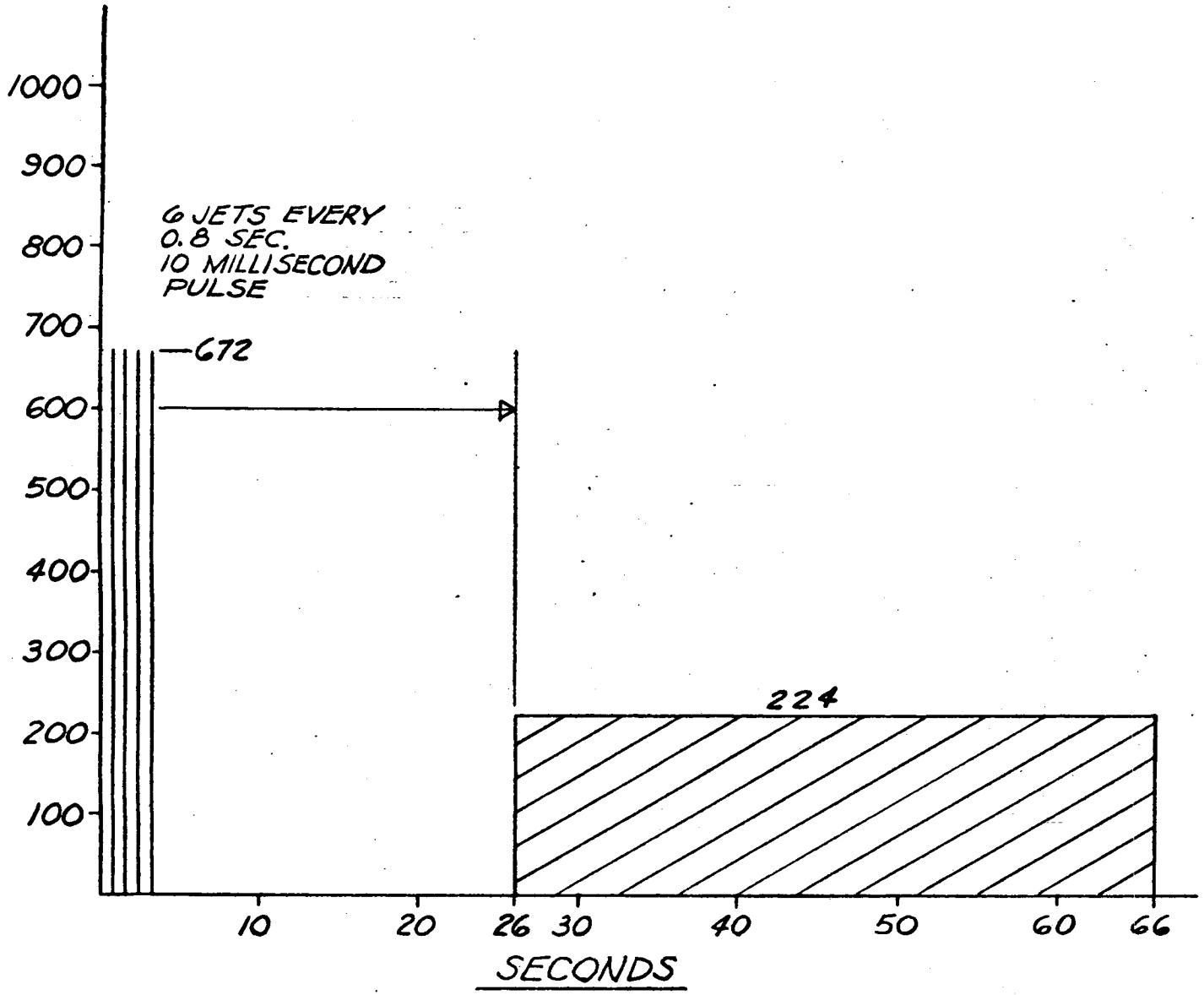
PHASE K-9

HOVER TO TOUCHDOWN

1.1 MIN.

ENERGY REQ. = 2.55 WATT-HRS.

Fig. G-2 Sheet 3



OCCURS DURING
PHASE 17 REF
LSK-390-10025A

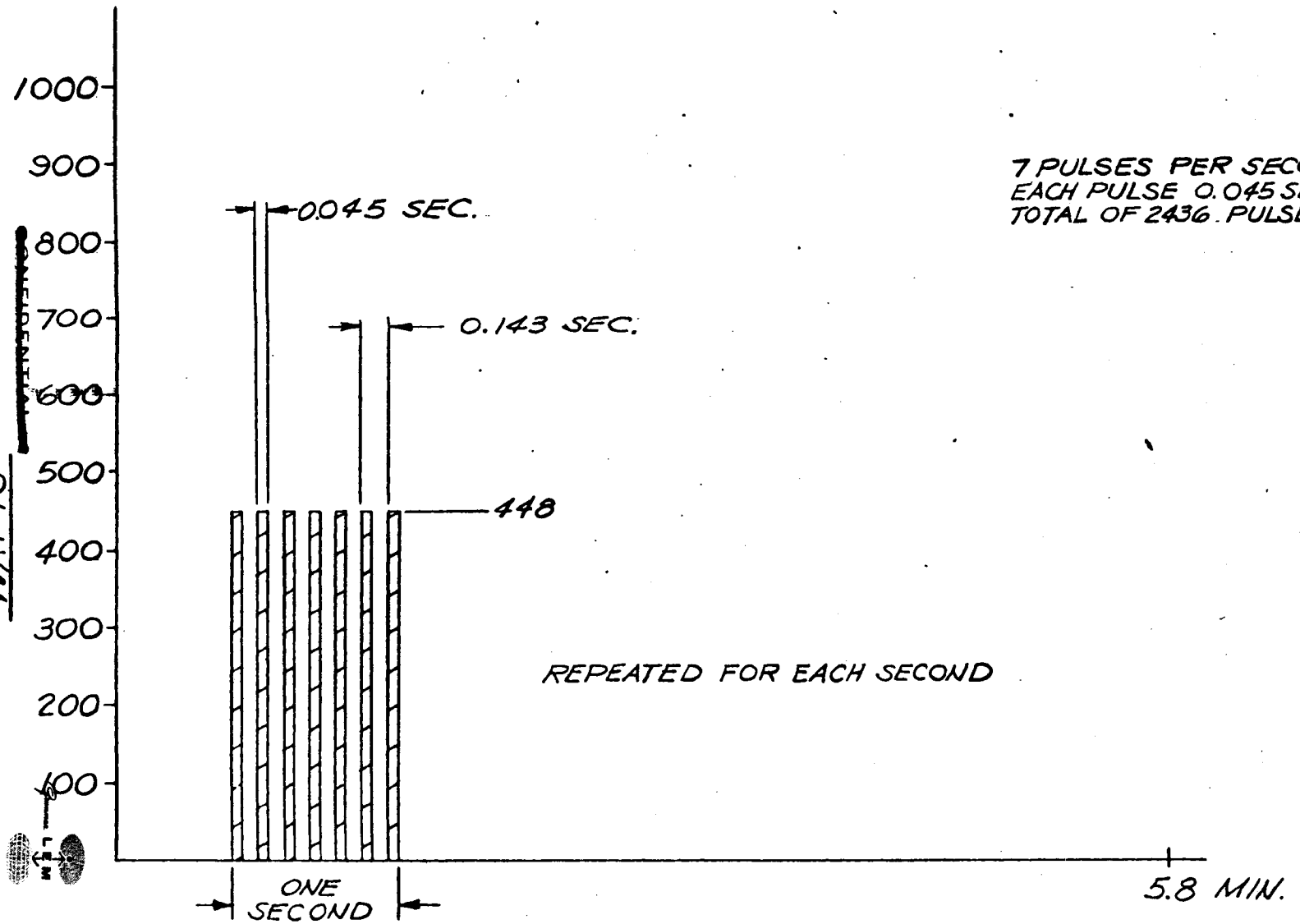
PHASE M-1

LIFT-OFF

ENERGY REQ. = 13.60 WATT-HRS.

5.8 MIN.

Fig. G-2 Sheet 4



OCCURS DURING
PHASE 17 REF
LSK-390-10025A

PHASE M-2, M-4

ROLL 180°

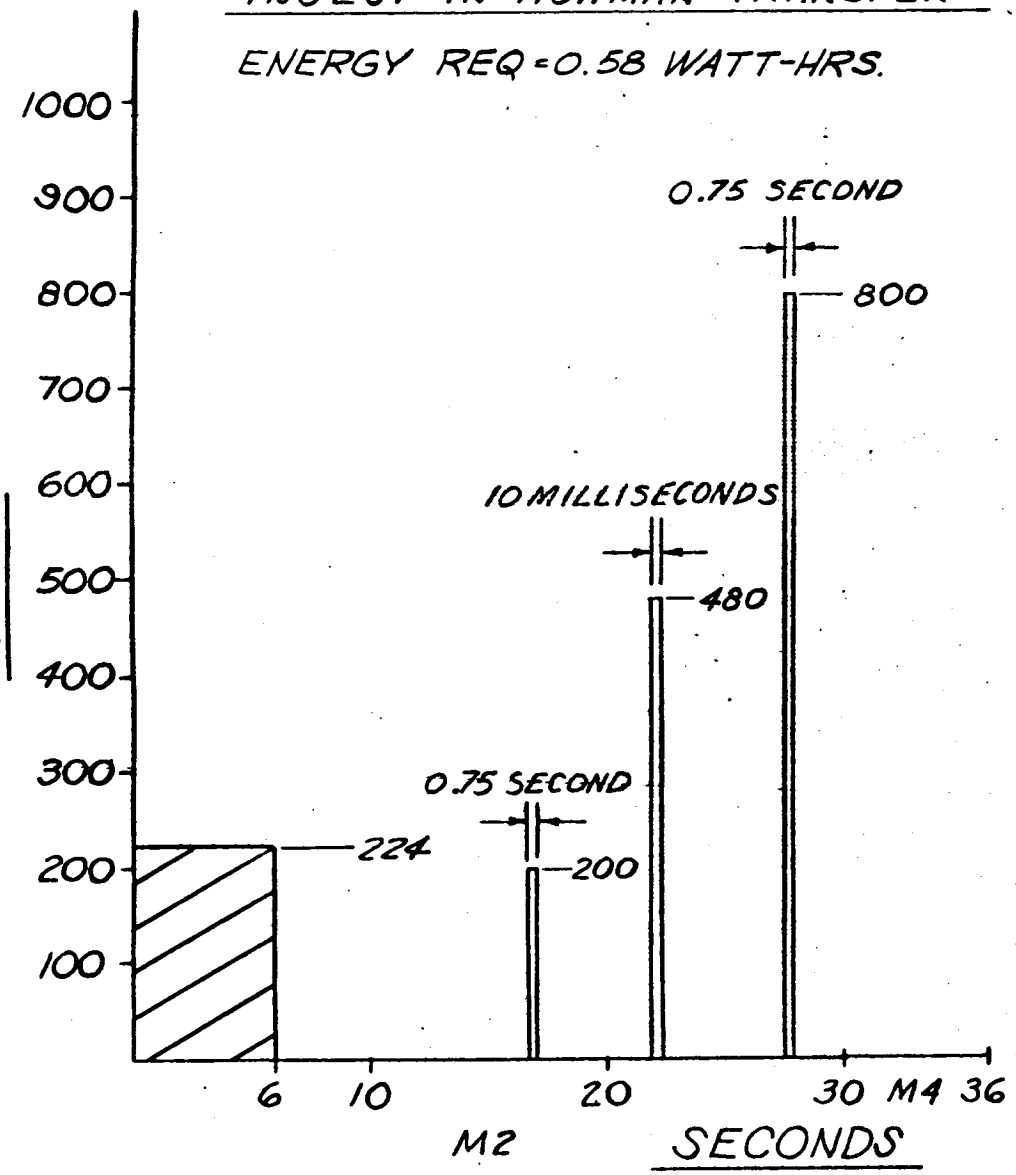
INJECT IN HOHMAN TRANSFER

ENERGY REQ = 0.58 WATT-HRS.

0.5 MIN.

0.1 MIN.

Fig. G-2 Sheet 5



PHASE M-5

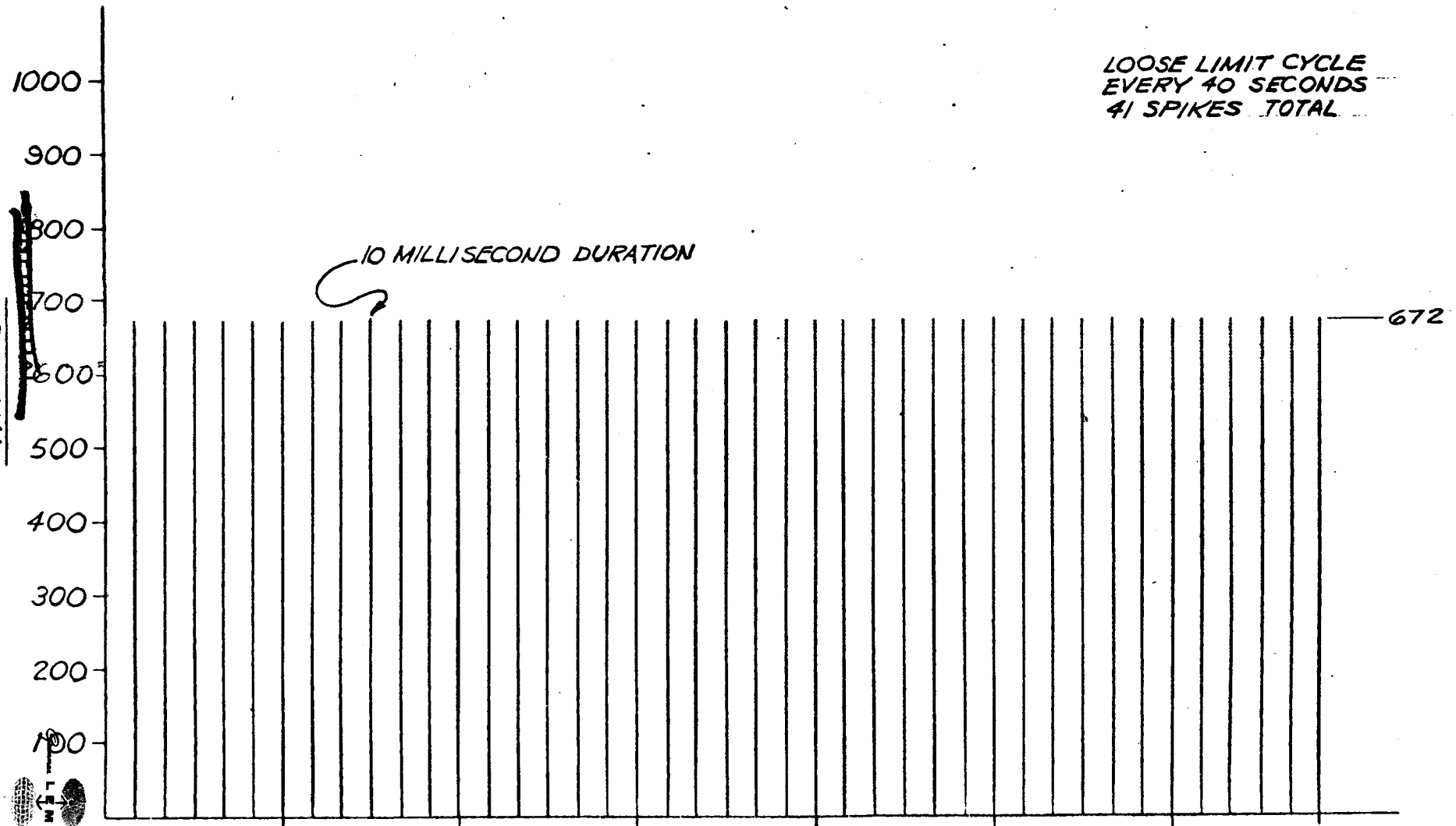
OCCURS DURING PHASE 19 REF LSK-390-10025A

COAST IN HOHMAN

34 MIN.

Fig. G-2 Sheet 6

ENERGY REQ = 0.08 WATT-HRS.



OCCURS DURING PHASE 19 REF LSK-390-10025A

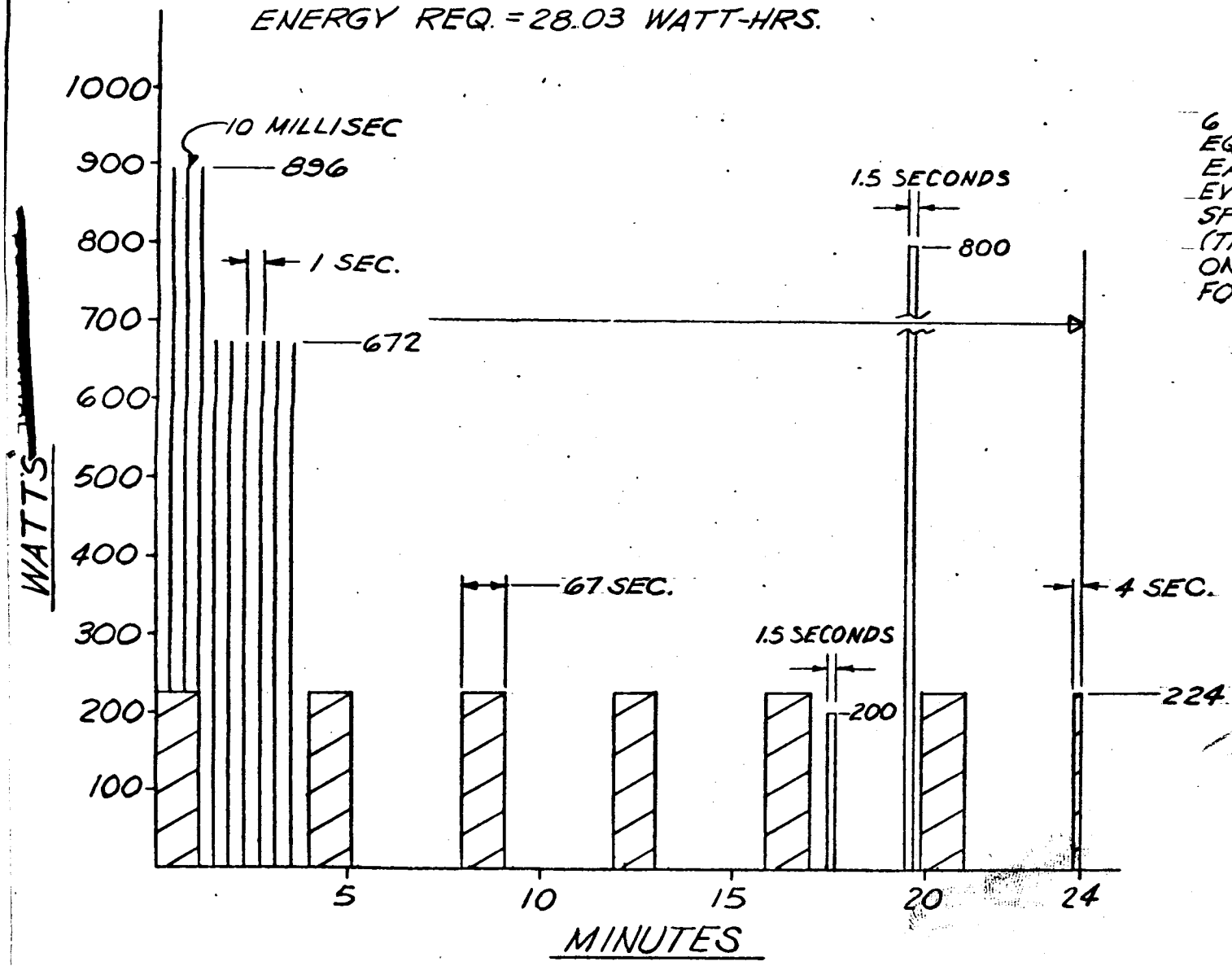
PHASE M6

HOME ON CM TO 500'
ROTATE 90° AFTER SIGHTING

24 MIN.

Fig. G-2 Sheet 7

ENERGY REQ. = 28.03 WATT-HRS.



6 224 WATT SPIKES EQUALLY SPACED EACH SPIKE 67 SEC. EVERY SEC. A 672 WATT SPIKE FOR TOTAL TIME (TIGHT LIMIT CYCLE) ONE 224 WATT SPIKE FOR 4 SEC. AT END

PHASE M-7

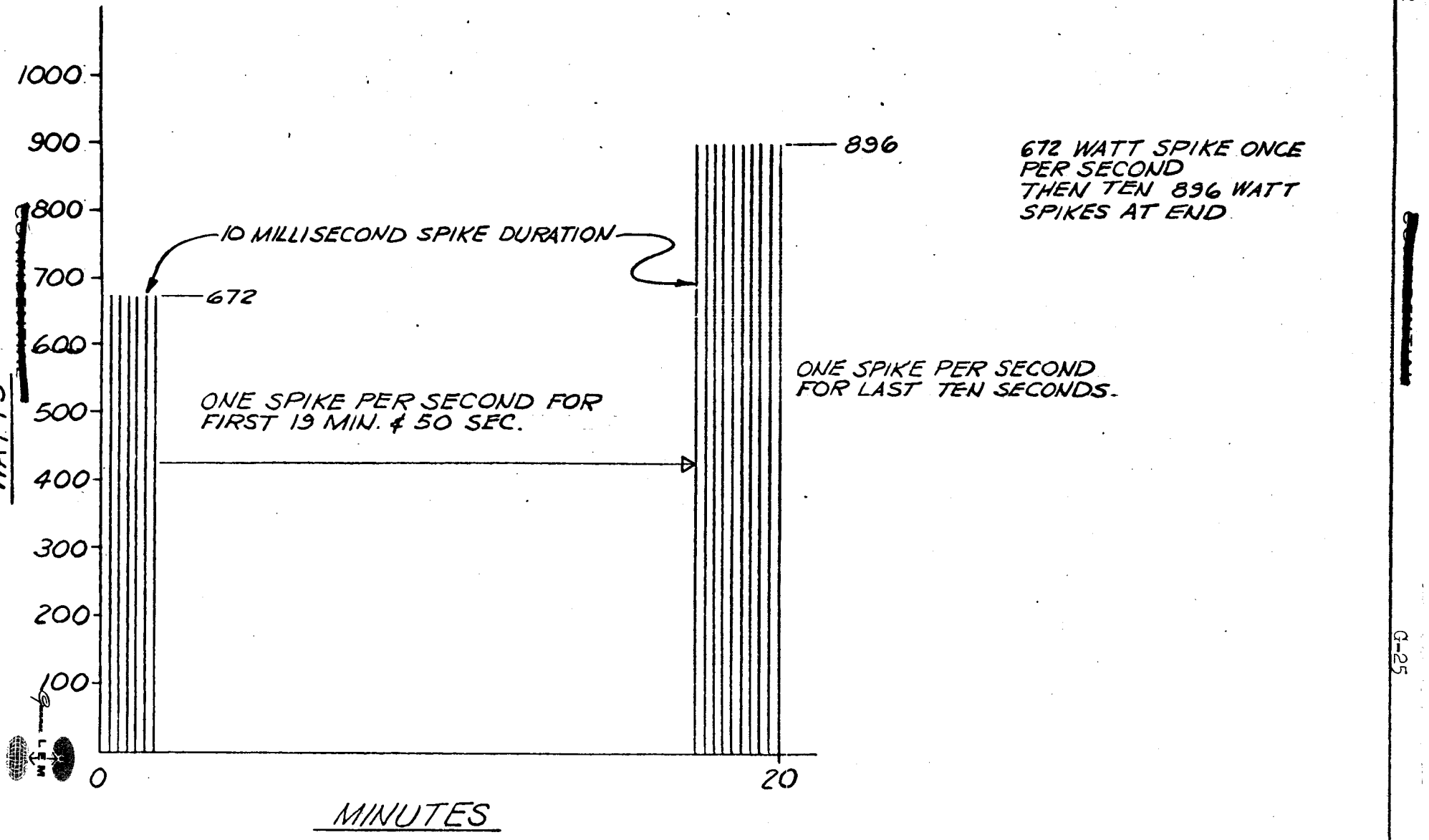
OCCURS DURING PHASE 19 REF LSK-390-10025A

DOCK FROM 500'

20 MIN.

Fig. G-2 Sheet 8

ENERGY REQ. = 2.24 WATT-HRS.



VOLUME III

PROGRAM MANAGEMENT PROPOSAL

3. GENERAL

The information requested by the subsequent paragraphs will be used to evaluate your management capability for performing the development of the equipment specified herein as part of the Lunar Excursion Module development. In addition, this information will be used to determine whether you have the required resources at your disposal. This volume shall be limited to fifty (50) 8.5 x 11 inch equivalent pages using 12 point elite type.

3.1 Past Experience and Performance. - Identify those programs which have been accomplished by the division or plant to which this work will be assigned and which you feel provides a specific background and capability to assure successful performance of the effort which you are proposing.

3.1.1 Define the function performed within the division or plant on the experience cited (i.e., Program Management, Associate Contractor, Feasibility Study, Subsystem Manager, Component Design, Manufacturing, etc.).

3.1.2 Discuss the technical complexities, urgency of schedule, scope of test programs required, and particular problems involved in controlling and accomplishing these past development programs.

3.1.3 Indicate any pertinent experience which has been gained elsewhere in your Company and describe how it would be utilized on this project. Your discussion should be limited to development programs which have specific applicability as to the scope and type of effort involved in this instance.

3.1.4 Appraise your own performance on these programs in the following areas:

(a) Accomplishment of technical objectives, including quality

(b) Control of cost

(c) Adherence to schedule requirements

3.1.4 (Continued)

Use the summary format of Table I to list the contracts involved in the program cited above.

3.1.5 On all cost-type contracts or subcontracts for over $100,000 which your plant or division has had in the past three years give the following data:

(a) Your originally proposed cost.

(b) Negotiated cost in the original definitive contract.

(c) Final (or current) negotiated fee-bearing cost.

(d) Actual cost (and current estimate at completion if not yet complete)

(e) Original contractual schedule and actual delivery or completion dates of the qualified prototype and the first deliverable item.

(f) The procuring agency or company, the name of the Contracting Officer or Buyer, and the contract or subcontract number.

(g) The type of work covered.

3.2 Organization and Personnel. -

3.2.1 Furnish a chart of your corporate organization as it currently is operating. Furnish a chart of your contemplated organization for this project and explain how it will work.

3.2.2 Discuss the proposed relationship to be maintained between your organization and subcontractor(s). Describe techniques for maintaining program coordination. Describe techniques to be employed in your organization for quick reaction solution to development problems that arise during the testing phase of the program.

3.2.3 Place on the organization chart the names of key personnel who will manage the project work. Using Exhibit 3 the vendor is requested to give a resume of the most senior personnel assigned full-time to the positions or areas listed below. Personnel supervising several areas or systems or a single area for several projects should not be listed.*

Program Manager
Assistant Program Manager
Material Manager
Contracts Manager
Quality Control Manufacturing Manager
Reliability
Senior Technical Engineer
Assistant Senior Technical Engineer

*Indicate the rol these individuals played in preparation of this proposal.

3.2.4 Discuss the scope of authority to be given the official designated to manage the project work. The contract may contain a clause giving Grumman the right to approve the selection or continued assignment of key personnel to this development effort.

3.3 Facility Capability. - Describe the activities or programs presently being performed by the division or plant to which this work will be assigned and explain how LEM work would be accommodated. List any future program which this division is committed to handle. Describe and graphically present workload by departments or skills and anticipated sales and the impact of these programs if awarded. Your should consider all of the pertinent aspects involved, i.e., technical manpower requirements, program capacity, etc.

3.3.1 Identify the current research, testing and manufacturing facilities that will be used for this project. Specifically indicate the ownership of these facilities and their availability for this project.

3.3.2 If no Government-owned facilities are to be used in the performance of the work quoted on herein, your quotation must include this statement:

"No Government-owned facilities will be used in performance of the work covered by this quotation."

3.3.3 If the use of Government-owned facilities is contemplated, you must submit dual prices, and other information, as follows:

(a) Unit price, without rental charge.

(b) Unit price including rental charge (stated separately) computed according to the terms of the Use Agreement or Contract under which the Government-owned facilities were furnished to you.

(c) The number of your Prime Facilities Contract/ Use Agreement and its expiration date.

(d) Name and address of the Contracting Officer administering your Facilities Contract/Use Agreement.

(e) The conditions under which the Government-owned facilities may be used on a rent-free basis in the performance of the proposed purchase order, as set forth in your current Use Agreement and whether or not you could perform the work in the event use of such facilities is denied.

3.3.4 Identify and describe the additional facilities including machinery, equipment, special test equipment to be acquired for the project. Indicate how these facilities will be provided. Key this list to the cost information requested in Section A. Special test equipment list should be "keyed" also to the specific test area where it is intended to be used. Discuss time phasing in relation to the Grumman schedule and particularly indicate any pacing or critical schedule items. Show graphically (plus photos) the test facilities to be used.

3.3.5 Discuss the need for plant alteration or rearrangement and modification of tooling, gauges and test equipment. Discuss time phasing in relation to the program schedule.

3.4 Make-or-Buy Plan. - Indicate your anticipated make-or-buy structure. Explain the basis on which it was developed and how you will provide for total system engineering integration. For those items you proposed to make, specify the division and location within your company. Particularly, identify the major components or part you will buy. Proposed subcontractors will be shown, however, each of the major elements of the make-or-buy structure will be subject to technical and administrative review and approval of Grumman prior to commencement of any work.

3.4.1 You are requested to consider the use of previously developed equipment and systems to the extent technically feasible. Any such proposed utilization should be identified in developing your make-or-buy program.

EXHIBIT 1

(1)	(2)	(3)	(4)	(5)
Contract No.	(a) Agency & Office Issuing (b) Technical or Project Office Monitoring	Item Description	Dollar Amount	Dates of Performance

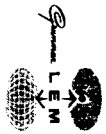


EXHIBIT 2

KEY PERSONNEL RESUME

NAME: _____ AGE: _____

PROPOSED ASSIGNMENT:

PRESENT ASSIGNMENT: (Company & division, time on job, type of responsibilities.)

PREVIOUS ASSIGNMENT: (Company & division, time on job, type of responsibilities.)

PREVIOUS ASSIGNMENT: (Company & division, time on job, type of responsibilities.)

OTHER SIGNIFICANT EXPERIENCE: (Company & division, time on job, type of responsibilities.)

EDUCATION: (degrees, major fields of study)

REMARKS:

VOLUME IV

COST PROPOSAL

4. General - Your proposal shall be prepared on the basis of the program schedule and hardware deliveries presented in Section B, in accordance with the requirements of Section C and the referenced Design Control Specification.

4.1 Summary - The vendor proposal shall contain, as a minimum the following summary information:

(a) A detail work statement reflecting the specific vendor interpretation(s) of the Grumman tasks described in Section C.

(b) A summary of the total labor required in man-months for each item in Section A for the labor categories of Engineering, Manufacturing, Tooling, Quality Control and Testing.

(c) A summary of the total hardware required by components as defined in Section C, paragraph 1.1 for each applicable item of Section A.

(d) A summary Form 533 modified for the total program per the instructions presented in Exhibit A.

(e) A total program cumulative cost curve is required.

(f) The total manhours to be proposed on Form 533 modified should be presented on a direct manpower curve by the five categories of labor (Engineering, etc.) Also required, a budgeted manpower summary curve, direct and indirect, for each of the five labor categories.

4.2 Detailed Cost Substantiation - The vendor shall present for each of the major items summarized in Section A, a form 533 modified per the instructions presented in Exhibit A. In addition to this form, the following supporting data (as a minimum) is required as outlined in the following paragraphs.

4.2.1 Task Description/Direct Cost Estimate Form 533A - A separate description will be completed for each sub-item or task (reference Section C). Each estimated category of labor, Engineering, Manufacturing, etc. associated with each sub-item or task described, should be spready over the performance period.

COST PROPOSAL (Continued)

4.2.2 Labor/Rate Breakdown, Form 533B - A detailed labor category breakdown substantiating the actual labor mix shall be presented as indicated by Form 533B.

4.2.3 Hardware Cost Breakdown, Form 533C - A detailed cost breakdown for each component will be presented per Form 533C. The cost buildup by elements relating to the 533 modified is to be interpreted as labor (Engineering, Manufacturing, Quality Control, etc., as applicable) and material cost.

4.3 Bill of Material - A completed system Bill of Material is defined as best available knowledge of subassemblies, parts and raw material which made up the particular unit. Indicate the basis for the proposed costs (best estimates, vendor quotations, standard part prices, historical purchase orders, etc.). List unit quantity and cost, and extended quantity and cost.

4.4 Rate Approval Support - The vendor shall furnish the name, address and telephone number of the cognizant audit agency.

4.4.1 If proposed direct labor, overhead, G and A, and other indirect rates have cognizant audit approval give approval document title, number, signing authority, and date.

4.4.2 In either case (government approval or not) the proposed and/or projected labor, overhead, G and A, and other indirect rate schedules and pools, current and historical, should be available for further Grumman review and discussion.

4.4.3 Indicate the basis and method for all projected direct and indirect rates.

4.5 Supporting Documentation - The vendor is required to maintain all formal and informal documentation supporting this proposal, as an evaluation may be made to review and validity of various cost elements prior to any possible contract award.

4.6 Tooling and Special Test Equipment - The vendor is required to support all tooling and special test equipment costs by a detail list. The format of this supporting data should in general follow the format of Form 533C.

4.7 Proposal Deviations - A complete list of all vendor requirement deviations taken by the vendor in preparation of his proposal are to be presented in this volume. Specific reference to the effected paragraph(s).

EXHIBIT A

COST PACKAGE INSTRUCTIONS

A. Form 533 Modified

1. Form 533 Modified shall be completed in its entirety for only the total program (cost element projection). For the major items (Section A) only the manhours (reference numbers 10 thru 50); total cost (reference number 80); total price (reference number 100); and commitments (balance outstanding and liability if terminated) need be spread over the "cost projected" columns. Also, the "total cost at completion" column must be completed for each of the major items.

2. For Cost Proposals, ignore the first two columns, "cost incurred", and complete the "cost projected" portion.

3. For subcontractor Cost Reports complete the two "cost incurred" columns and the "cost projected" columns starting with the current quarter of the government fiscal year. Show the quarterly breakdown for the balance of the current fiscal year and the two following fiscal years, the balance to complete, if any, and the total cost at completion. The form is to be submitted monthly so as to reach Grumman by the 5th day of the calendar month, showing cost incurred through the prior month and an up-to-date projection showing the current realistic total cost at completion. Monthly "cost incurred" may be an estimate based on incomplete accounting data to the extent necessary to meet the submission date; any resulting discrepancies will be corrected as necessary the following month.

4. Direct Labor - Show Direct Labor (reference number 10-50) in average number of Direct Manhours during the monthly report period or projected per quarter, including "job shopper" labor. To the extent possible show all direct labor in one of the five indicated categories (Engineering, Tooling, Manufacturing, Quality Control and Test). Companies which subdivide labor into more categories should combine them as logically as possible into the five major categories.

5. Direct Labor Dollars - Show Direct Labor Dollars resulting from the application of Direct Labor Rates.

EXHIBIT A (Continued)

6. Overhead - Show the appropriate overhead cost (reference number 11, 12, and/or 13) by application of current projection to direct labor categories, (reference 10 thru 50).

7. Outside Cost - Show Cost-Type subcontracts (including tasks assigned to other divisions of your company if your subcontract with Grumman is a cost-type) at your anticipated rate of payment to subcontractor. Do not show commitment value. Also complete and submit a copy of this Form for each cost-type subcontract.

8. Show all other costs for Raw Material, Purchased Parts, Fixed Price Subcontracts, etc. at your anticipated rate of aggregate expenditure. For Cost Proposals attach schedule showing details.

9. Show indirect material factors, if any, such as overhead, attrition, etc.

10. Show the total amount of other direct costs in your accounting system such as travel, per diem, consultants, rentals, overtime premium, taxes, etc. Attach a schedule of explanation.

11. For cost reporting requirements show Outstanding Commitments resulting from orders placed but not yet paid. Show the estimated liability on these commitments in case of termination as a dollar amount based on some fraction of the balance of outstanding commitments. NOTE: In case of incremental funding of a subcontract, show "Balance Outstanding: as if the subcontract were fully funded, "Liability if Terminated" will reflect the limited funding.

B. Form 533A Task Description/Direct Cost Estimate

1. For each of the major items the vendor will submit a Form 533A listing the sub-items and/or tasks under the "Description" column. The listing should reflect logically the sub-items and tasks (outline in Section C) related to each major item.

EXHIBIT A (Continued)

2. The description should be a brief definition of work performance by labor category, per reference number 10 through 50 of Form 533 modified. The appropriate manhours for each labor category spread over the time periods in which the work will be performed.
(NOTE: Specific reference is made to quality labor classification (Form 533 modified, reference number 40) related to the individual sub-items. This breakout should reflect detailed quality functions such as receiving inspection, vendor control, quality engineering, manufacturing inspection, etc.)

3. If a specific sub-item or task is subcontracted, the subcontracted cost amount should be spread logically.

C. Form 533B Labor/Rate Breakdown

The purpose of this form is to delinate the Form 533 modified direct labor categories into the specific categories of labor and/or cost centers and appropriate rates. It should be emphasized that the completing of this form should be consistent with the subcontractor's own designations. The labor classifications used are arbitrary and were incorporated as an illustration.

D. Form 533C Hardware Cost Breakdown

Manhours (by appropriate labor category), material and other cost elements are to be listed for each of the component types. This format may be superseded by an equivalent form as long as the basic requirements are fulfilled.

E. Form DD 633-2 Cost and Price Analysis Form for Technical Publications

A DD 633-2 Form should be completed for the support manual portion of the Documentation item only.

EXHIBIT A (continued)

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

IRM PROGRAM

Subcontractor Cost Report (Based on Costs Incurred through--)

Subcontractor _____
Subsystem _____
Component _____
Item _____
Date _____

Ref No	COST ELEMENTS	Cost Incurred: This Report Period	Cost Incurred: To Date	Cost Projection: FY 63 4th Qtr	Fiscal 64: 1st	Fiscal 64: 2nd	Fiscal 64: 3rd	Fiscal 64: 4th	Fiscal Year 196- : 1st	Fiscal Year 196- : 2nd	Fiscal Year 196- : 3rd	Fiscal Year 196- : 4th	Fiscal Year 196- : 1st	Fiscal Year 196- : 2nd	Fiscal Year 196- : 3rd	Fiscal Year 196- : 4th	Bal. to Complete	Total to Completion	Tot. Prod. Total Cost at Completion
	Man Hours																		
10	Engineering																		
20	Tooling																		
30	Manufacturing																		
40	Quality Control																		
50	Test																		
	TOTAL MAN HOURS																		
	Direct Labor																		
10	Engineering																		
20	Tooling																		
30	Manufacturing																		
40	Quality Control																		
50	Test																		
	TOTAL DIR. LABOR DOLLARS																		
	Overhead																		
111	Engineering ($)																		
112	Tooling ($)																		
113	Manufacturing ($)																		
120	Tooling Mat'l. & Purch.Parts																		
125	Raw Mat'l. & Purch.Parts																		
126	Indirect Mat'l. Factors																		
128	Subcontracts																		
150	Other Direct Labor Costs																		
151	Outside Consultants																		
152	Travel																		
153	Other Costs																		
170	G&A Expense																		
190	TOTAL COST																		
200	PROFIT																		
200	TOTAL PRICE																		
	Commitments																		
	Balance Outstanding																		
	Liability if Terminated																		

Form 533 Modified

EXHIBIT A (continued)

Subcontractor
Subsystem
Component
Plan
Date

TASK DESCRIPTION/DIRECT COST ESTIMATE

Sub Task	Task Description	Cost Element	FY 63 4th Qtr.	FY 63 1st	Fiscal 196- 2nd	Fiscal 196- 3rd	Fiscal 196- 4th	Fiscal 196- 1st	Fiscal 196- 2nd	Fiscal 196- 3rd	Fiscal 196- 4th	Fiscal 196- 1st	Fiscal 196- 2nd	Fiscal 196- 3rd	Fiscal 196- 4th	Balance	Total

EXHIBIT A (continued) GRUMMAN Item:_____

Labor/Rate Breakdown

_____ (Item Title)

Company: Phone No._____

Address:

RFP or Contract No._____
Proposal Expires:_____
S/C Proposal No._____
Date of Proposal_____

Where work will be performed if different from above-or subcontractor

Actual time of performance from_____to_____

Ref. No.		Set-up Hours	Hours	Rate	Extention
10.	Engineering				
10.1	Project Engineer				
10.2	Senior Engineer				
10.3	Engineer				
10.4	Senior Designer				
10.5	Draftsman				
10.6	Lab Technician				
10.7	Others				
20.	Tooling				
20.1	Senior Designer				
20.2	Toolmaker A				
20.3	Others				
30.	Manufacturing				
30.1	Machinist 1st Class				
30.2	Technician				
30.3	Assembler				
30.4	Others				
40.	Quality				
40.1	Inspector A				
40.2	Quality Engineering				
40.3	Others				
6	Consultant				
63	Rented or Leased Equipment (e.g., Computer Time, etc.)				

ALL SUB-CATEGORIES (10.1, 10.2, etc.) SHALL BE VENDOR'S OWN DESIGNATION FOR THOSE NORMALLY INCLUDED UNDER THE MAJOR CATEGORIES (10, 20, etc.) SHOWN.

FORM 533B

EXHIBIT A (continued) GRUMMAN

Hardware Cost Breakdown

Bill of Materials

Item: _____

(Item Title)

ompany: Phone No.	RFP or Contract No.
	Proposal Expires:
ddress:	S/C Proposal No.
	Date of Proposal
here work will be rformed if fferent from bove-or subcontractor	Actual time of performance from ____ to ____

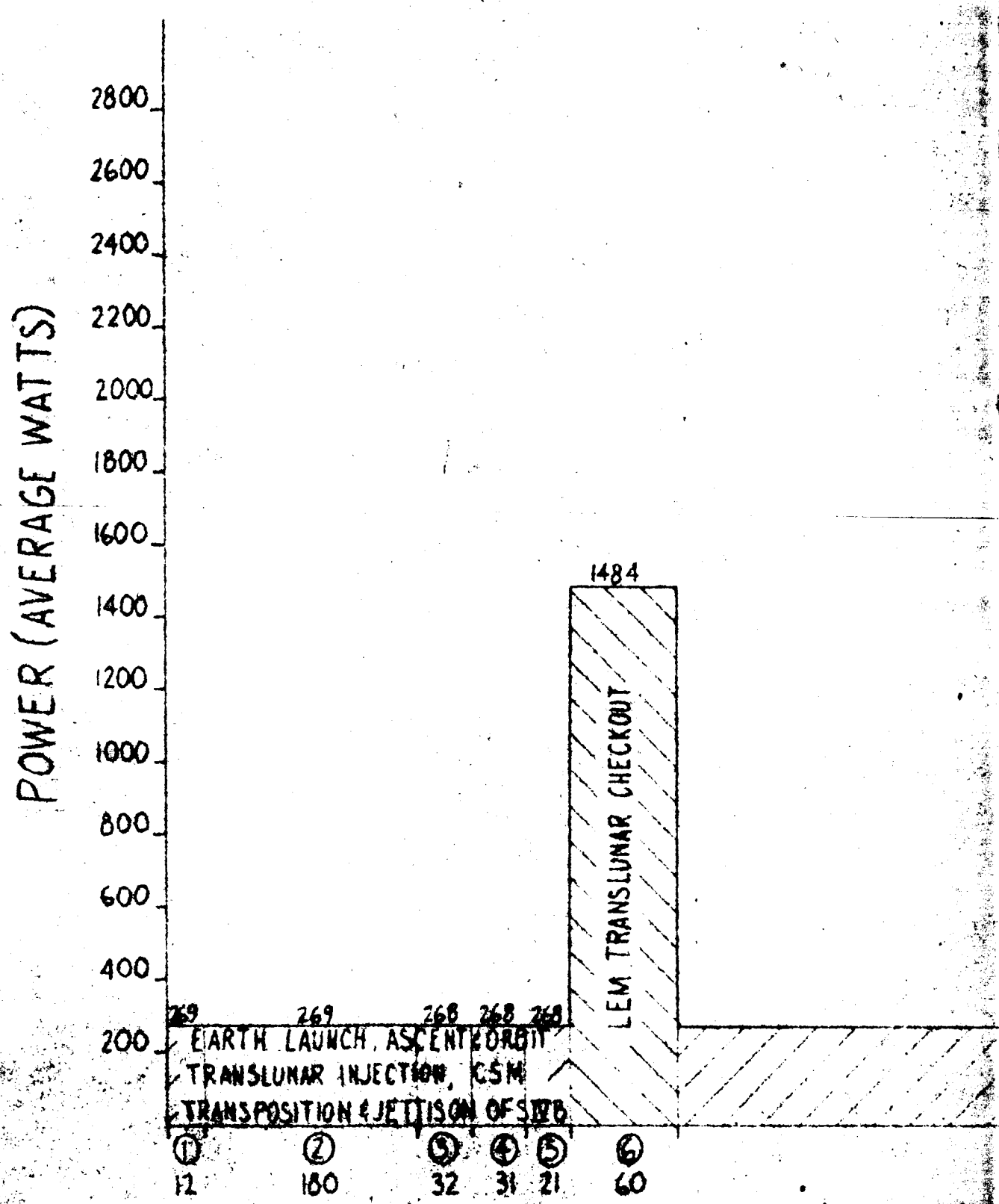
Description	Cost build-up elements relating to 533 Mod.	Unit Cost	Quantity	Total	% of Total

NOTE: Identify all "common use hardware."

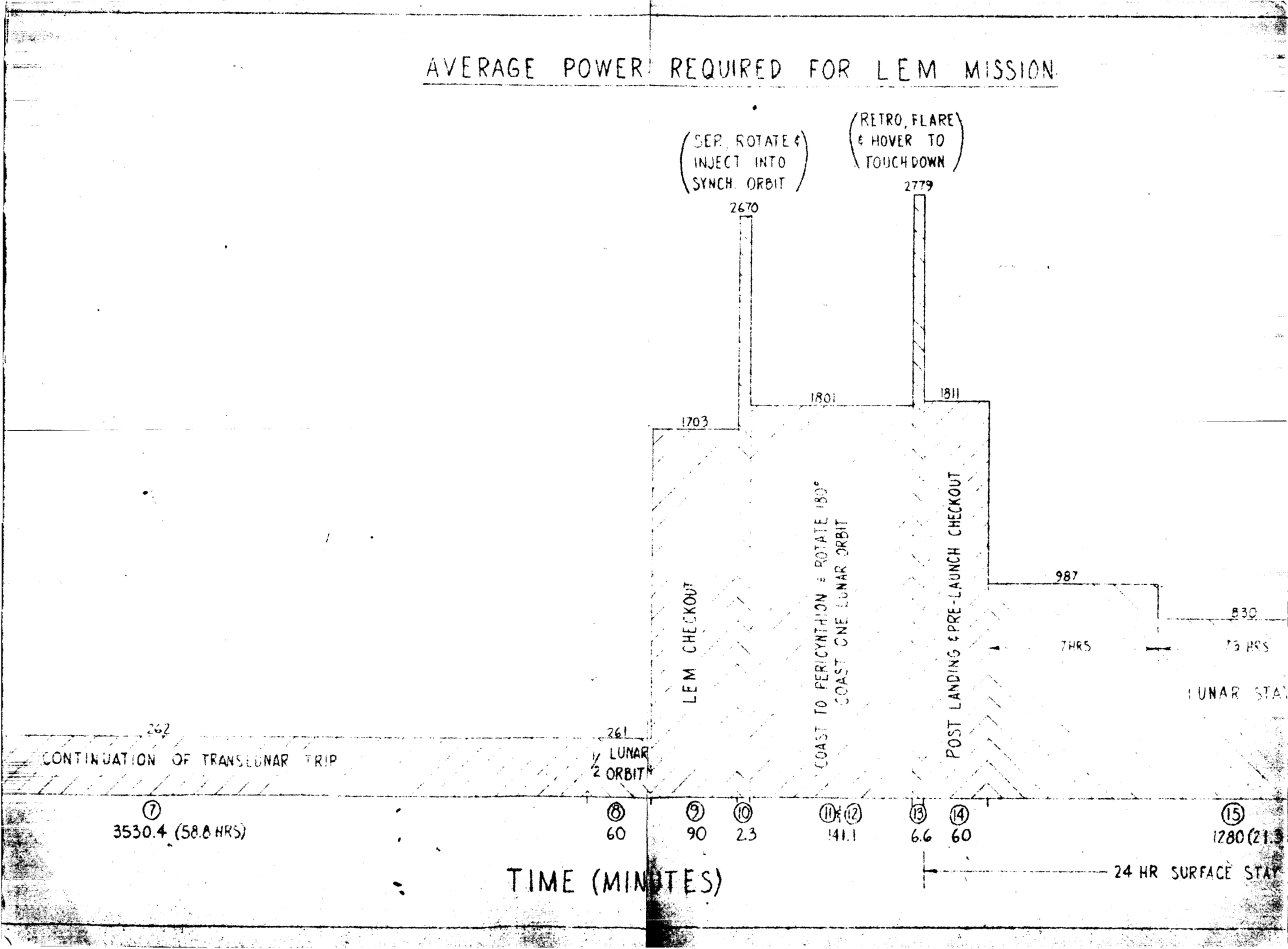
TOTAL

Grumman LEM

orm 533c


POWER (AVERAGE WATTS)
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
1484
LEM TRANSLUNAR CHECKOUT
269
269
268
268
268
EARTH LAUNCH, ASCENT, ORBIT
TRANSLUNAR INJECTION, CSM
TRANSPOSITION & JETTISON OF SIVB
1
2
3
4
5
6
12
180
32
31
21
60

AVERAGE POWER REQUIRED FOR LEM MISSION



LEM ELEC POWER SUBSYSTEM

LVR 390-2

Figure G-1